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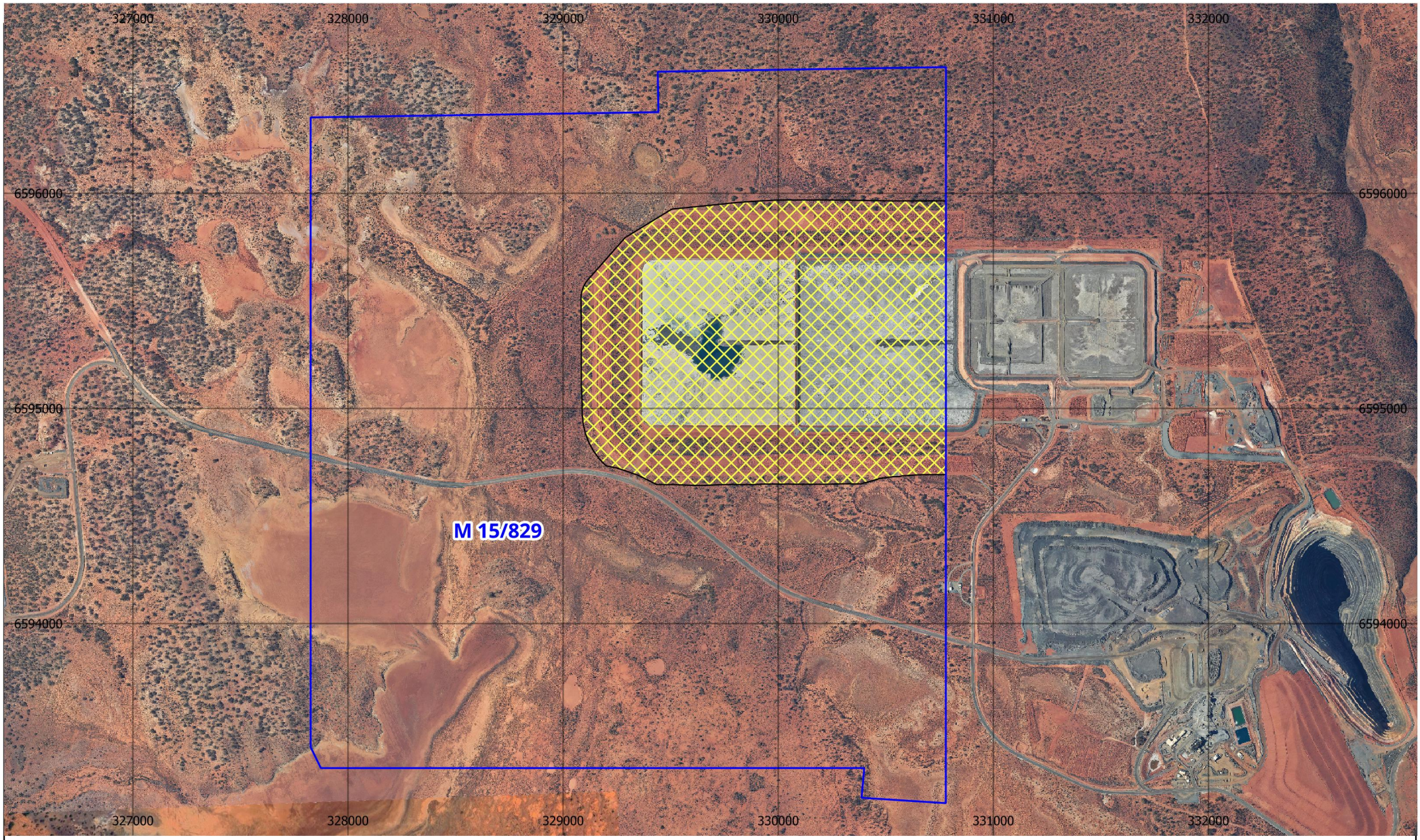
Appendix A: Aerial Map of Clearing Permit Area



CPS 8797 Plan

0 0.5 1 km

GDA2020 / MGA zone 51

LEGEND

TSF Cells 3 & 4 Tenement

Clearing Instrument

CPS 8797/2

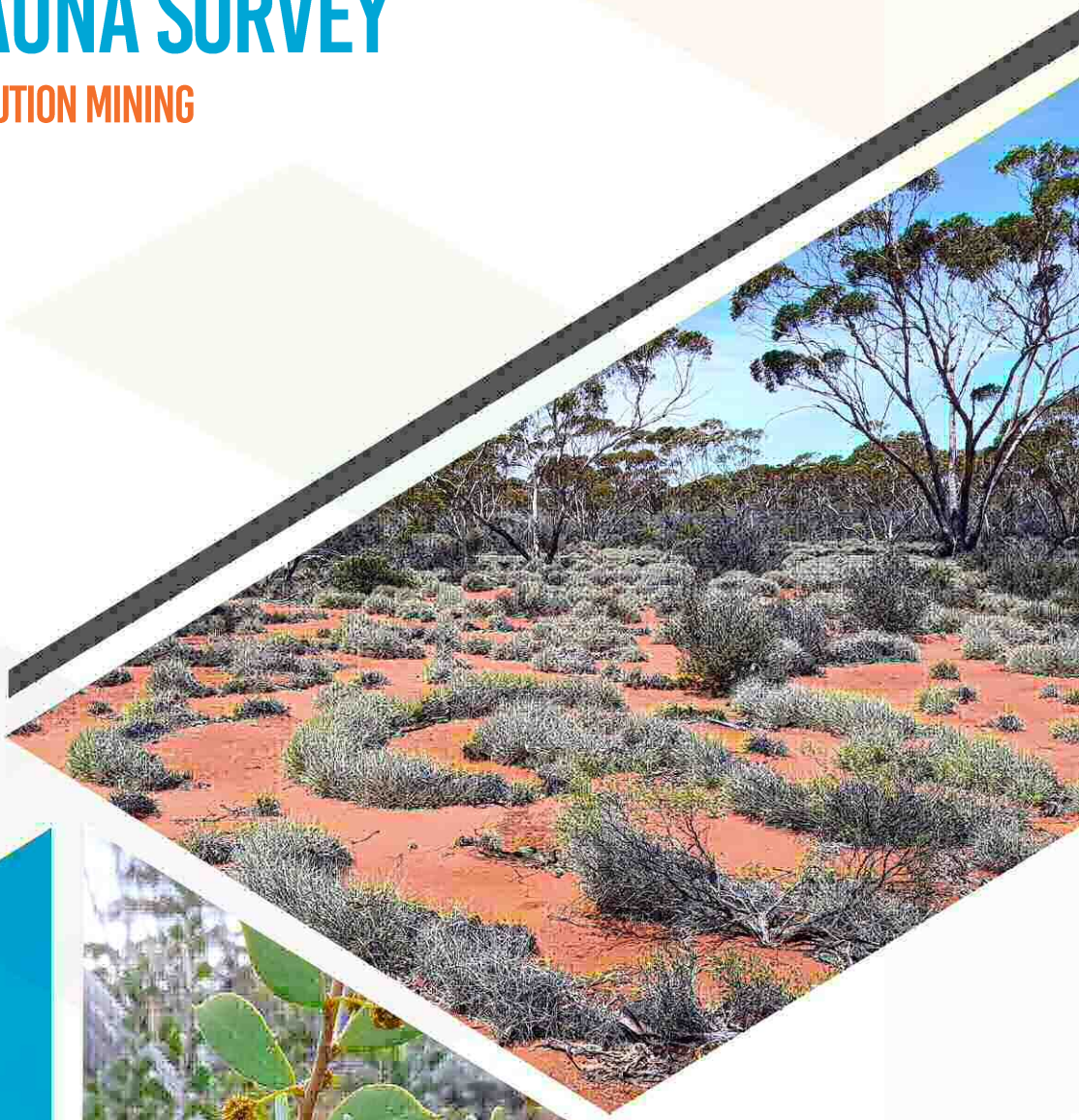
Author: L. Oliveira
Date: 08/01/2025

Evolution MINING
Mungari

Appendix J: Supporting Biodiversity Survey (Reconnaissance Flora & Level 1 Fauna Survey)

RAYJAX & CASTLE HILL RECONNAISSANCE FLORA & LEVEL 1 FAUNA SURVEY

PREPARED FOR: EVOLUTION MINING



Spectrum ECOLOGY

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Report Details			
Project Description:	Rayjax & Castle Hill Reconnaissance Flora & Level 1 Fauna Survey		
Prepared For:	Evolution mining		
Project ID:	1927		
Version History	Author	Reviewer	Date of Issue
Version 1	Carmel Forrester (Flora) Astrid Heidrich (Fauna)	Dr Cam Mounsey	19-Sep-19

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EXECUTIVE SUMMARY

Evolution Mining are exploring options to mine at various locations within the Mungari Gold Project tenements, located 600 km east of Perth and 20 km west of Kalgoorlie in the Goldfields region of Western Australia. Spectrum Ecology was engaged to complete a Reconnaissance flora and vegetation survey and Level 1 fauna survey at:

- Castle Hill mine and Haul Road (Castle Hill study area),
- Rayjax mine and Haul Road (Rayjax study area),
- Burgundy to Cutters Ridge Haul Road, and
- Tailings Storage Facility (TSF).

Throughout this report, these areas may also be referred to as 'study areas'. In addition, a desktop Subterranean Fauna survey was completed in corporation with Bennelongia Environmental Consultants at the above study areas, along with the Cutters Ridge mine and Haul Road.

Flora

113 taxa from 28 families and 49 genera were recorded during the survey, one of which was an introduced taxon; **Erodium cicutarium*.

No Threatened flora taxa were recorded in the study areas during the current assessment or considered likely to occur. Three significant flora taxa were identified in the study area during the current survey or during the desktop assessment:

- Priority 1: *Calandrinia lefroyensis/quartzitica, Eremophila praecox* (desktop); and
- Priority 3: *Allocasuarina eriochlamys* subsp. *grossa* (current survey) (outside study area).

An additional three significant flora were assigned a high likelihood of occurrence within the study areas, but not identified during the field survey:

- Priority 3: *Austrostipa blackii*;
- Priority 4: *Eucalyptus jutsonii subsp. jutsonii*; and
- Species of Interest: *Calandrinia* sp. Gypsum (F. Obbens & L. Hancock FO 10/14).

One of these taxa was considered to have high significance at a regional scale if impacted at the study area: *Calandrinia lefroyensis/quartzitica* (Priority 1).

Two of these taxa were considered to have high significance at a local scale if impacted at the study area including: *Calandrinia lefroyensis/quartzitica* (Priority 1), and *Calandrinia* sp. Gypsum (species of interest). These taxa have relatively few records in the local area.

Vegetation

Eleven vegetation types, mostly dominated by Eucalyptus species, were described throughout the study areas occurring on flat plains, claypans or lake beds, minor drainage lines, simple slopes, and minor floodplains. An assessment of vegetation condition (as per EPA 2016b), showed the majority of vegetation within the study areas was in Pristine (42.5%) or Excellent (52.3%) condition with few disturbances noted. A small area was mapped as Good (5.1%) and was characterised by quarries or mining activities.

No vegetation types in the study areas were considered to represent a Threatened Ecological Community (TEC) or Priority Ecological Community (PEC), or have a high degree of historical impact, or provide a function to maintain ecological integrity of a significant ecosystem.

Eight of the vegetation types were considered significant due to either providing refuge to significant species or being restricted within the study areas. Of these, three were considered to have high significance at a local scale, if impacted at the study area:

ii: *Tecticornia halocnemoides* ssp. *halocnemoides*, *T. indica* ssp. *indica* and *T. chartacea* low open chenopod shrubland;

v: *Casuarina pauper* low isolated trees over *Melaleuca laterifora* mid open shrubland over *Frankenia setosa* and *Atriplex stipitata* low open shrubland; and

vii: *Eucalyptus griffithsii* low woodland over *Senna artemisioides* and *Eremophila ionantha* mid sparse shrubland over *Acacia hemiteles* and *Grevillea acuaria* low sparse shrubland.

Type vii is possibly restricted in the region and was considered to have high significance at a regional scale if impacted at the study area.

Fauna

Eight survey sites were established at each of the Castle Hill and Rayjax study areas, seven survey sites at Burgundy to Cutters Ridge Haul Road, and 14 survey sites were established at the TSF Area.

A total of four fauna habitat types were recorded from the study area: Disturbed Eucalypt Woodland, Gentle Hillslope with Eucalypt Woodland, Minor Drainage Line, and Open Eucalypt Woodland over Open Tall Shrubs. At the Rayjax study area two fauna habitats were recorded: Mixed Eucalypt Woodland and Gentle Hillslope with Eucalypt Woodland. At the Burgundy to Cutters Ridge Haul Road four fauna habitat types were recorded: Gentle Hillslope with Eucalypt Woodland, Mixed Eucalypt Woodland, Minor Drainage Line, and Floodplain. A total of four fauna habitat types were recorded from the study area: Eucalypt Woodland over Open Shrubland, Mixed Dense Shrubland, Claypan and Saltbush Shrubland. In addition, some areas were already cleared which do not represent a habitat type as such.

A total of 11 vertebrate fauna species and 13 potential SRE invertebrate fauna species were recorded during the survey at the Castle Hill study area. A total of eight vertebrate fauna species and nine potential SRE invertebrate fauna species were recorded from the Rayjax study area. Fifteen vertebrate fauna species and 11 potential SRE invertebrate fauna taxa were recorded from the Burgundy to Cutters Ridge Haul Road. A total of 13 vertebrate fauna species and five potential SRE invertebrate fauna taxa were recorded during the survey at the TSF area.

No conservation significant fauna was recorded during the survey at the study areas.

The desktop Subterranean Fauna survey identified seven species of stygofauna and 11 species of troglofauna potentially occurring in the area. However, no PEC calcrete aquifers or other highly prospective stygofauna or troglofauna habitats occur close to the study areas.

1. INTRODUCTION

1.1. Project Background

Evolution Mining is a gold mining company with multiple projects across Australia. The Rayjax and Castle Hill Project Area is a proposed project situated 20-30 km north and west (respectively) of regional towns Coolgardie and Kalgoorlie, in Western Australia, and approximately 530 km east of Perth.

Spectrum Ecology was commissioned to undertake a Reconnaissance Flora and Vegetation Assessment, and Level 1 Fauna Assessment of various locations at the Rayjax and Castle Hill Project Area (1378 ha), and includes Castle Hill (451.7 ha), Rayjax (146.9 ha), Burgundy to Cutters Ridge Haul Road (354.2 ha) and Tailings Storage Facility (TSF; 425.5 ha). The study areas include Open Pits, Tailings Storage Facility (TSF), Haul Roads, and their associated infrastructure (Map 1.1). Some sections in and around the study areas have had recent flora and fauna studies completed (within 5 years). Known previous studies are listed in Section 1.8.

The objectives of the Reconnaissance flora and vegetation assessment and Level 1 fauna assessment are:

- To verify the information obtained from the desktop study and characterise the flora, vegetation, fauna and fauna habitats present; and
- To clarify whether the study area may potentially support any significant flora, vegetation, fauna or fauna habitats.

1.2. Legislation and Guidance

Flora and fauna in Western Australia are protected by various legislation, including:

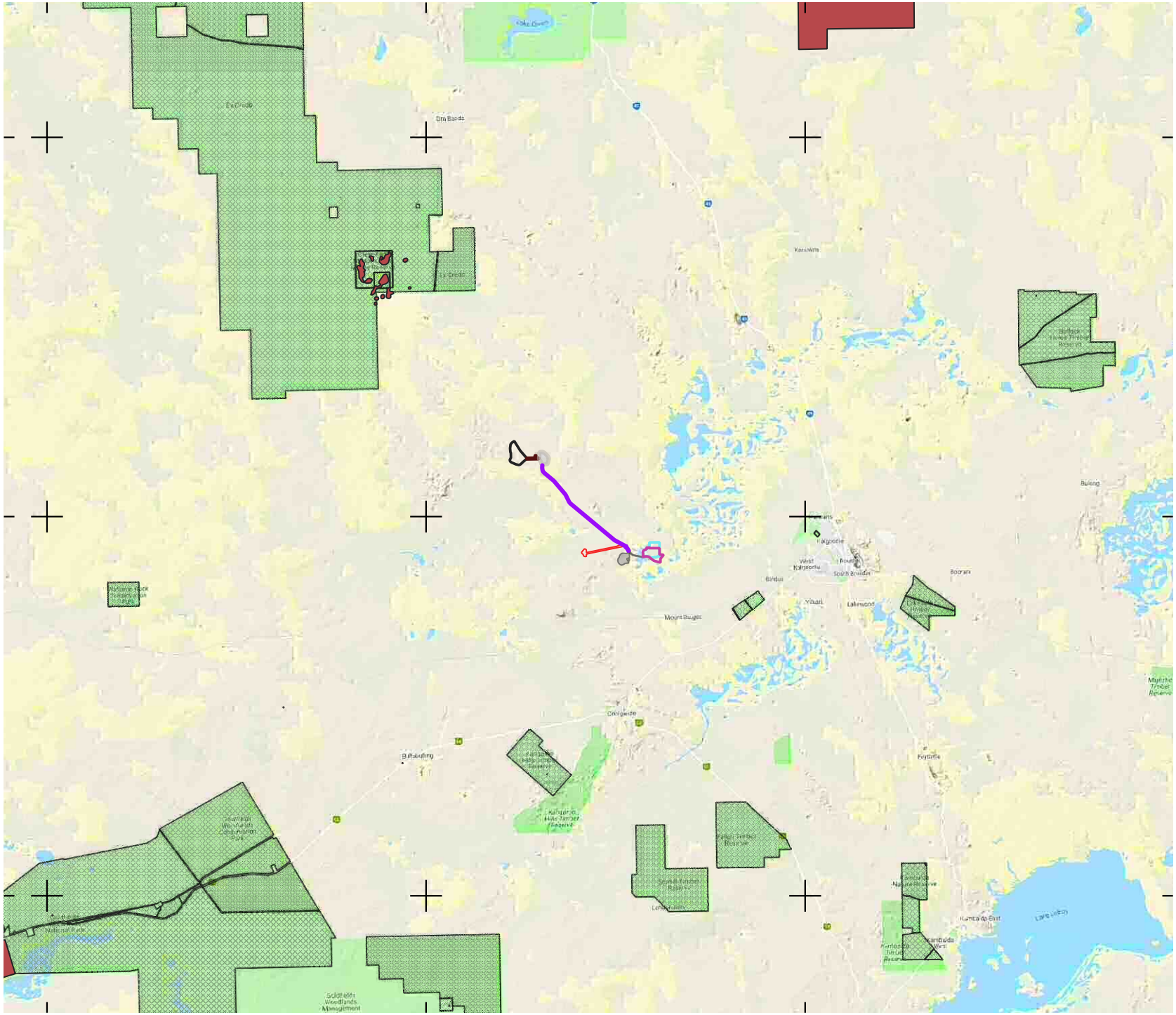
- Biodiversity Conservation Act 2016 (BC Act), which replaced the Wildlife Conservation Act 1950 (WC Act) as of 1 January 2019 (Government of Western Australia, 2016);
- Wildlife Conservation Act 1950;
- Environmental Protection Act 1986 (EP Act); and
- Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) (Department of the Environment and Energy, 2016 [DotEE]).

The surveys are compliant with Reconnaissance flora and vegetation survey guidelines and Level 1 fauna survey guidelines, as outlined in:

- EPA Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment (Environmental Protection Authority, 2016b [EPA]);
- EPA Technical Guidance: Terrestrial Fauna Surveys (EPA 2016e); and
- EPA Technical Guidance: Sampling Methods for Terrestrial Vertebrate Fauna (EPA 2016d).

This assessment is also consistent with the following guidelines:

- EPA Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002);
- EPA Environmental Factor Guideline: Flora and Vegetation (EPA 2016a);
- National Vegetation Information System (NVIS) Australian Vegetation Attribute Manual (ESCAVI, 2003);
- EPA Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA 2004); and
- EPA & DEC Technical Guide: Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA and DEC, 2016)



Legend

Conservation Estate

Environmentally Sensitive Area

Study Area

- Rajax Mine & Haul Road
- Burgundy to Cutters Ridge Haul Road
- Castle Hill Haul Road
- Castle Hill Mine
- Burgundy Mine (not included in current survey)
- Cutters Ridge Mine
- TSF 3&4
- TSF3 Area

N

10 0 10

Scale 1:700000 @ A4

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: AH Approved: DC Date: 13-09-2019

Location of the Study Areas

Rayjax to Castle Hill

Map 1.1

Prepared for
Evolution Mining

1.3. Bioregion and Climate

The Interim Biogeographic Regionalisation for Australia (IBRA) classifies Australia into regions based on dominant landscape, climate, lithology, geology, landform and vegetation (Thackway and Cresswell, 1995). The study area is situated in the Coolgardie IBRA region; a large region which forms an interzone between the Mediterranean climate of the south-west and the arid inland of Western Australia. The Coolgardie bioregion is characterised by granite outcrops, low greenstone hills, laterite uplands, broad plains and numerous salt lakes. The climate of the Coolgardie bioregion is classified as arid to semi-arid, warm Mediterranean, with 250 to 300 mm of mainly winter rainfall, annually (McKenzie, May and McKenna, 2003).

The Coolgardie region is divided into three sub-regions: Southern Cross, Eastern Goldfield and Mardabilla. The study area is located within the Eastern Goldfield sub-region (Figure 1.1), which is characterised by subdued relief of gently undulating plains, interrupted in the west by low hills and ridges of greenstones and in the east with granulites. Calcareous earths are the dominant soil group and a series of salt lakes occur in the west that are remnants of an ancient drainage line (Cowen, 2001).

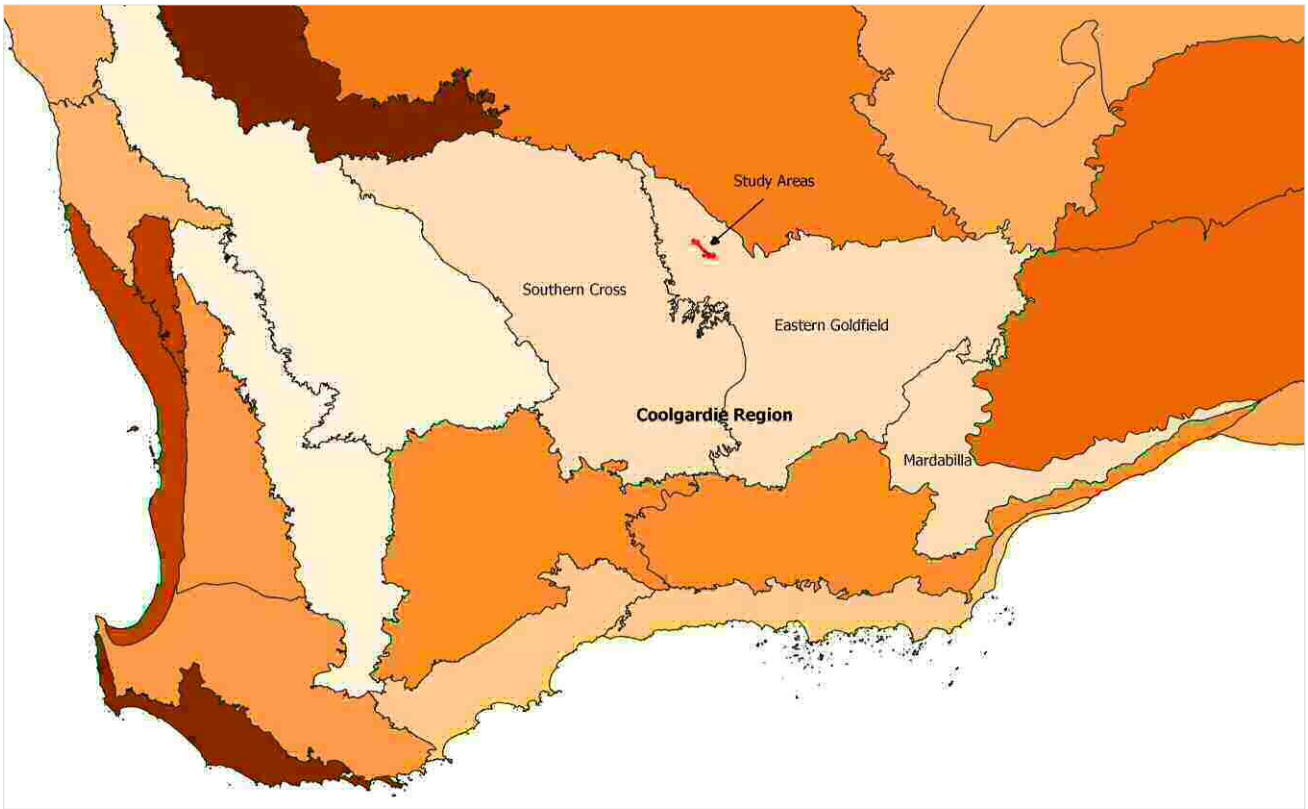


Figure 1.1: IBRA Classification of the Study Areas

1.4. Disturbance History

The dominant current and historical land uses and their associated disturbances across the Coolgardie region include: unallocated crown land (low impact recreational disturbance), pastoral leases (disturbance from grazing by sheep and cattle), and mining leases (disturbance of relatively small areas with high impact, drill lines etc.). Logging for fuel was previously conducted in the region from 1890 to 1950 but these areas are now regenerating (Cowen, 2001).

1.5. Geology

The geology of Western Australia has been mapped at a scale of 1:250,000 (DMIR 2019). Nine units have been mapped within the Castle Hill study area, four units have been mapped within the Rayjax study area, eight units are mapped from the Burgundy to Cutters Ridge Haul Road, and three units are mapped from the TSF area. These are listed in Table 1.1 and mapped in Map 1.2. None of the geological units mapped at the study area have more than 1.6% of their total extents mapped within.

Table 1.1: Geological Units of the Study Area (1:250,000)

Code	Description	Area in Study Area (ha)	% of Study Area	Area in WA (ha)	% of WA Extent
Castle Hill					
Ab	Basalt, includes doleritic layers and lenses	120.9	26.7	35,647.9	0.3
Abm	Komatiitic basalt, includes variolitic basalt and basalt with relic (pyroxene) spinifex texture	1.1	0.2	9,098.6	<0.1
Agbl	Bali monzogranite: porphyritic, with biotite	1.3	0.3	3,752.3	<0.1
Agkn	Kintore tonalite: equigranular, with biotite	2.8	0.6	177.6	1.6
Ao	Medium- and corse-grained mafic rocks; mainly gabbro and dolerite	47.4	10.5	4,991.1	0.9
Au	Ultramafic rocks; includes tremolite(-chlorite) and talc-chlorite(-carbonate) schists	34.8	7.7	3,702.6	0.9
Auk	Komatiite with relict olivine spinifex texture	68.1	15.1	26,737.3	0.2
Czc	Colluvium - gravel, sand, and silt as sheetwash or talus	10.6	2.4	444,247.0	<0.1
Czl	Laterite and reworked products	164.47	36.43	138,961.6	0.1
Rajax					
Abm	Komatiitic basalt, includes variolitic basalt and basalt with relic (pyroxene) spinifex texture	9.3	6.4	9,098.6	0.1
Ao	Medium- and corse-grained mafic rocks; mainly gabbro and dolerite	33.3	22.7	4,991.1	0.7
Auk	Komatiite with relict olivine spinifex texture	56.7	38.6	26,737.3	0.2

Code	Description	Area in Study Area (ha)	% of Study Area	Area in WA (ha)	% of WA Extent
Czc	Colluvium - gravel, sand, and silt as sheetwash or talus	47.6	32.4	444,247.0	<0.1
Burgundy to Cutters Ridge Haul Road					
Abm	Komatiitic basalt, includes variolitic basalt and basalt with relic (pyroxene) spinifex texture	15.3	4.3	9,098.6	0.2
Afv	Felsic volcanic and volcaniclastic rocks	18.3	5.2	13,552.4	0.1
Aogw	Powder sill: gabbro and quartz gabbro	19.7	5.6	2,843.3	0.7
As	Pelitic and psammitic sedimentary rocks; includes conglomerate, chert and felsic volcaniclastic rocks	14.5	4.1	5,880.2	0.3
Czc	Colluvium - gravel, sand, and silt as sheetwash or talus	243.1	68.6	444,247.0	0.1
Czl	Laterite and reworked products	19.9	5.6	138,961.6	<0.1
Cztd	Sand, silt, and gypsum in stabilized dunes adjacent to playas	4.2	1.2	69,707.9	<0.1
Qa	Alluvium - clay, silt, sand, and gravel in channels	19.1	5.4	72,917.0	<0.1
TSF					
Afv	Felsic volcanic and volcaniclastic rocks	0.1	<0.1	13,552.4	0.0
Cztd	Sand, silt, and gypsum in stabilized dunes adjacent to playas	392.9	92.3	69,707.9	0.6
Czts	Evaporite interbedded with clay and sand in playas	32.5	7.6	25,568.2	0.1

Legend

Geological Units (1:250,000)

- Ab
- Abm
- Afv
- Agbl
- Agkn
- Ao
- Aogw
- As
- Au
- Auk
- Czc
- Czl
- Cztd
- Czts
- Qa

Study Areas

- Burgundy & Cutters Ridge
- Burgundy to Cutters Ridge Haul Road
- Castle Hill Haul Road
- Castle Hill Mine
- Rajax Mine & Haul Road
- TSF 3 & 4

N

Scale 1:100000

1 0 1 2 km

@ A4

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: AH Approved: DC Date: 18-09-2019

Geological Mapping of the Study Areas

Rayjax to Castle Hill

Map 1.2

Prepared for
Evolution Mining

1.6. Vegetation

Pre-European vegetation mapping was originally undertaken by Beard at various scales across the state and has since been updated to be consistent with the National Vegetation Information System (NVIS) descriptions at a scale of 1:250,000 (Department of Primary Industry and Regional Development, 2019).

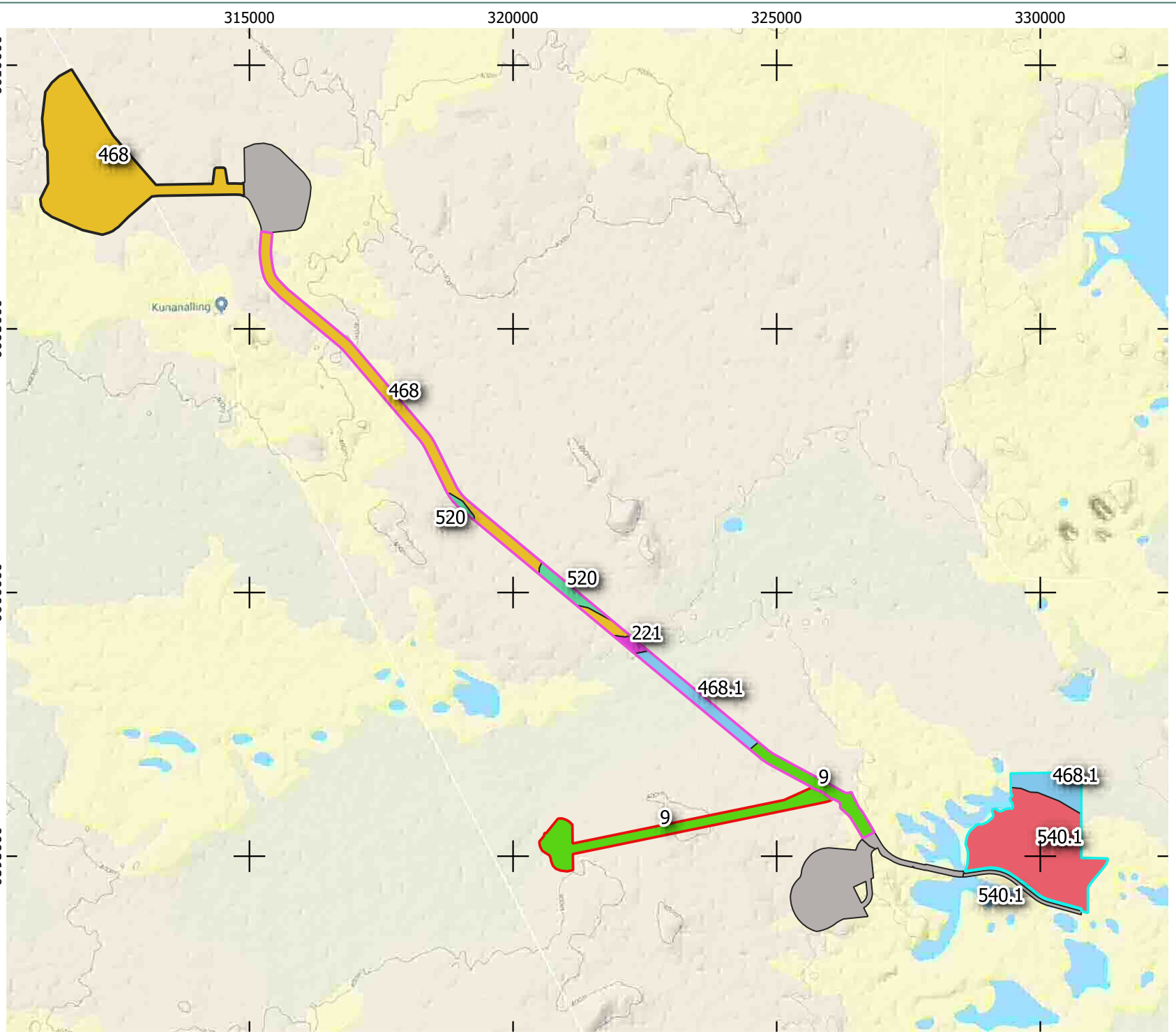
One unit (468) has been mapped within the Castle Hill study area, one unit (9) has been mapped in the Rayjax study area, five units (9, 221, 468, 468.1, 520) have been mapped within the Burgundy to Cutters Ridge study area, and two units (468.1, 540.1) have been mapped inside the TSF Area. The units are listed in Table 1.2 and shown in Map 1.3. State-wide vegetation statistics are available for these units which list pre-European extent, current extent, area in DBCA managed lands etc., and is a useful tool to determine if a vegetation unit is rare or otherwise significant (Government of Western Australia, 2019).

There are 179 Beard vegetation units within the Coolgardie Bioregion, six of which are mapped within the study areas. The majority of the six Beard vegetation units recorded at the study areas are widespread across Western Australia. The least widespread units; 520 (30,988 ha), 540.1 (49,482 ha), and 221 (52,086 ha) are associated with habitats that are restricted in the study areas including salt lakes and drainage channels.

Table 1.2: Vegetation Associations Mapped Within the Study Areas

Sub-association	NVIS Level V Vegetation Description	Area in Study Area (ha)	% of Study Area	Pre-European Whole State (ha)	Current Extent State (ha)	% Remaining	% of Current Extent in DBCA Land
Castle Hill							
468	*Eucalyptus salmonophloia, E. dundasii* mid woodland over isolated shrubs and isolated ground species	451.7	100.0	442,147	438,249	99.1	30.4
Rayjax							
9	*Eucalyptus torquata, E. lesouefii, E. clelandiorum* (syn: *clelandii*) low woodland over *Eremophila scoparia, E. glabra, E. oldfieldii* tall sparse heathland and sparse chenopod shrubland over isolated ground species	146.9	100.0	240,509	235,161	97.8	8.1
Burgundy to Cutters Ridge Haul Road							
9	As above	64.46	18.2	240,509	235,161	97.8	8.1
221	Isolated trees and isolated shrubs over *Atriplex* sp. low open shrubland and open chenopod shrubland	10.04	2.8	55,627	52,086	93.7	20.4
468	As above	188.23	53.2	442,147	438,249	99.1	30.4
468.1 - mosaic	*Eucalyptus lesouefii, E. salmonophloia, E. transcontentalis* tall woodland, over *Eremophila scoparia, E. alternifolia, E. decipiens* tall open shrubland	58.46	16.5	66,475	62,253	93.7	2.1
520	Isolated trees over *Acacia quadrimarginea* tall shrubland over isolated ground species	32.98	9.3	31,514	30,988	98.3	53.5
TSF area							
540.1	*Casuarina cristata* subsp *cristata, Myoporum platycarpum, Callitris columellaris* low open woodland over *Eremophila miniata, Grevillea sarissa* tall sparse shrubland over *Atriplex*	363.10	85.3	51,663	49,482	95.8	0

Sub-association	NVIS Level V Vegetation Description	Area in Study Area (ha)	% of Study Area	Pre-European Whole State (ha)	Current Extent State (ha)	% Remaining	% of Current Extent in DBCA Land
	hymenotheca low open shrubland and low open chenopod shrubland						
468.1 - mosaic	As above	62.41	14.7	66,475	62,253	93.7	2.1



Legend

Pre-European Vegetation units

- 9
- 221
- 468
- 468.1
- 520
- 540.1

Study Areas

- Burgundy & Cutters Ridge
- Burgundy to Cutters Ridge Haul Road
- Castle Hill study area
- Cutters Ridge
- Rajax Mine study area
- TSF 3 & 4

N

1 0 1 2 km

Scale 1:100000 @ A4

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: AH Approved: DC Date: 18-09-2019

Pre-European Vegetation Mapping of the Study Areas

Rayjax to Castle Hill

Map 1.3

Prepared for
Evolution Mining

1.7. Conservation Estate and Environmentally Sensitive Areas

Searching the Collaborative Australian Protected Area Database (CAPAD), several small state protected areas and two commonwealth protected areas were found located within 60km of the study area. These protected areas and their approximate distance from the study area are listed in Table 1.3.

Table 1.3: Protected Areas within the Vicinity of the Study Area

Reserve Name (Protected Area ID)	Relevant to the Study Area		Comment (Jurisdiction/Size)
	Distance	Direction	
5(1)(g) Reserves			
Kangaroo Hills (5(1)(g)) (WA_19211)	25 km	South	Western Australia, 3120 (ha)
Lakeside Timber (5(1)(g)) (WA_19215)	37 km	East	Western Australia, 2390 (ha)
Scahill (5(1)(g)) (WA_19621)	35 km	South	Western Australia, 6915 (ha)
5(1)(h) Reserves			
Kalgoorlie Arboretum (5(1)(h)) (WA_23840)	25 km	East	Western Australia, 26 (ha)
Yallari Timber (5(1)(h)) (WA_19212)	35 km	South	Western Australia, 6077 (ha)
Nature Reserves			
Clear and Muddy Lakes (WA_07634)	27 km	North West	Western Australia, 1926 (ha), Within Credo National Reserve
Kurrawang (WA_35453)	15 km	East	Western Australia, 635 (ha),
Conservation Parks			
Goldfields Woodlands (WA_46127)	57 km	South West	Western Australia, 34,408 (ha)
Rowels Lagoon (WA_04274)	27 km	North West	Western Australia, 404 (ha), Within Credo National Reserve, Nationally Important Wetland.
Wallaroo Rock (WA_27655)	58 km	West	Western Australia, 1214 (ha)
National Reserve/Parks			
Credo National Reserve (CWTH_N7121)	20 km	North West	Commonwealth, 202, 000 (ha)
Goldfields Woodlands (WA_46126)	57 km	South West	Western Australia, 646,000 (ha)

There are no Conservation Estates or Environmentally Sensitive Areas found within the study areas. The closest is the Credo National Reserve, 20 km to the north-west of the study areas. Conservation Estate and ESAs within the vicinity are mapped in Map 1.1.

1.8. Database Searches

1.8.1. Flora and Vegetation Database Searches

A desktop review of all relevant and available flora and vegetation data sources was undertaken prior to the field survey to assess the flora and vegetation likely to occur in the study area. The Database searches include:

- Department of Biodiversity, Conservation and Attractions (DBCA) Threatened and Priority Flora database search (DBCA ref.: 08-0819FL, 50km buffer);
- DBCA Threatened Ecological Communities (TEC) and Priority Ecological Communities (PEC) database search (DBCA ref.: 1927, 50km buffer);
- DBCA and WA Museum NatureMap online database (20 km and 40 km radius);
- EPBC Protected Matters search tool (40 km buffer);
- Index of Biodiversity Surveys and Assessments (IBSA) Database; and
- Previous survey reports supplied by the client.

DBCA database searches worked from a polygon that encompassed all components of the study areas (see Table 1.4). DBCA searched within a 50 km buffer the polygon. The NatureMap searches worked from a central point in the study areas with a 20 km and 40 km buffer. Relevant results from the database searches are summarised in Table 1.4 and mapped on Map 1.4.

Table 1.4: Summary of Database Searches Undertaken for the Assessment

Source	Custodian	Comments
Threatened and Priority Flora (TPFL)	DBCA	Polygon plus 50km buffer. 204 Conservation Significant Flora records found.
Western Australian Herbarium (WAHerb)	DBCA	Polygon plus 50km buffer. 31 Conservation Significant Flora records found
Threatened and Priority Ecological Communities (TPEC)	DBCA	Polygon plus 50km buffer. No Conservation Significant Vegetation
NatureMap	DPAW^ / WAM^^	Central point, radial buffer of 20 km and 40 km. Searches returned, respectively, 5 and 50 Conservation Significant flora species.
Protected Matters	EPBC	Central point with 40km buffer. Three Endangered plants may have habits occur in the area, but are not known from this area. One Nationally Important Wetland (Rowels Lagoon) occurs within the vicinity of the study area.
Index of Biodiversity Surveys and Assessments (IBSA)	DBCA	N/A
Botanica Consulting, 2014, Level 2 Flora & Vegetation Survey for the Burgundy Project	Evolution Mining	Previous botanical survey in the vicinity of the current Rayjax & Castle Hill Study Area. No Conservation Significant Flora Recorded.
Phoenix Environmental Science, 2018, Flora and Vegetation Survey for the Cutter's Ridge Project	Evolution Mining	Previous Survey within current Rayjax & Castle Hill Study Area. Five Conservation Significant Flora recorded.
Native Vegetation Solutions, 2013 - 2019, Vegetation Monitoring Impact Study of the Mungari Tailings Storage Facility.	Evolution Mining	Previous Survey within current Rayjax & Castle Hill Study Area. No Priority Flora recorded.

^ Department of Parks and Wildlife. ^^ Western Australian Museum

An assessment of each significant species or community identified in the above data searches was completed with the following information provided:

- Conservation status (EPBC Act, WC Act, DBCA listing);
- Description of species habitat requirements and presence of this habitat within the study area;
- Summary of relevant records including source of record (DBCA, previous report etc.) and accuracy of the record location; and
- Likelihood of occurrence criteria assigned and justification of likelihood of occurrence that considers known habitats, survey effort etc. The likelihood of occurrence will be determined based on the criteria outlined in Table 1.5.

Table 1.5: Likelihood of Occurrence Criteria – Flora and Vegetation

Likelihood	Criteria
Recorded	Species or community recorded within study area
High	Species or community recorded in close proximity to study area and suitable habitat occurs in the study area
Medium	Species or community recorded outside the study area but within 20°km suitable habitat occurs in the study area.
Low	Species or community rarely or not recorded within 20°km of the study area. Suitable habitat does not occur within or in close proximity to the study area.

1.8.1.1. Flora

Sixty-two significant taxa were identified during the flora database searches and these are summarised in Table 1.6. A full list of likelihood of occurrence is provided in Appendix A. Records are mapped in Map 1.4. Coordinates of mapped records are available upon request.

Table 1.6: Significant Flora Recorded from Database Searches

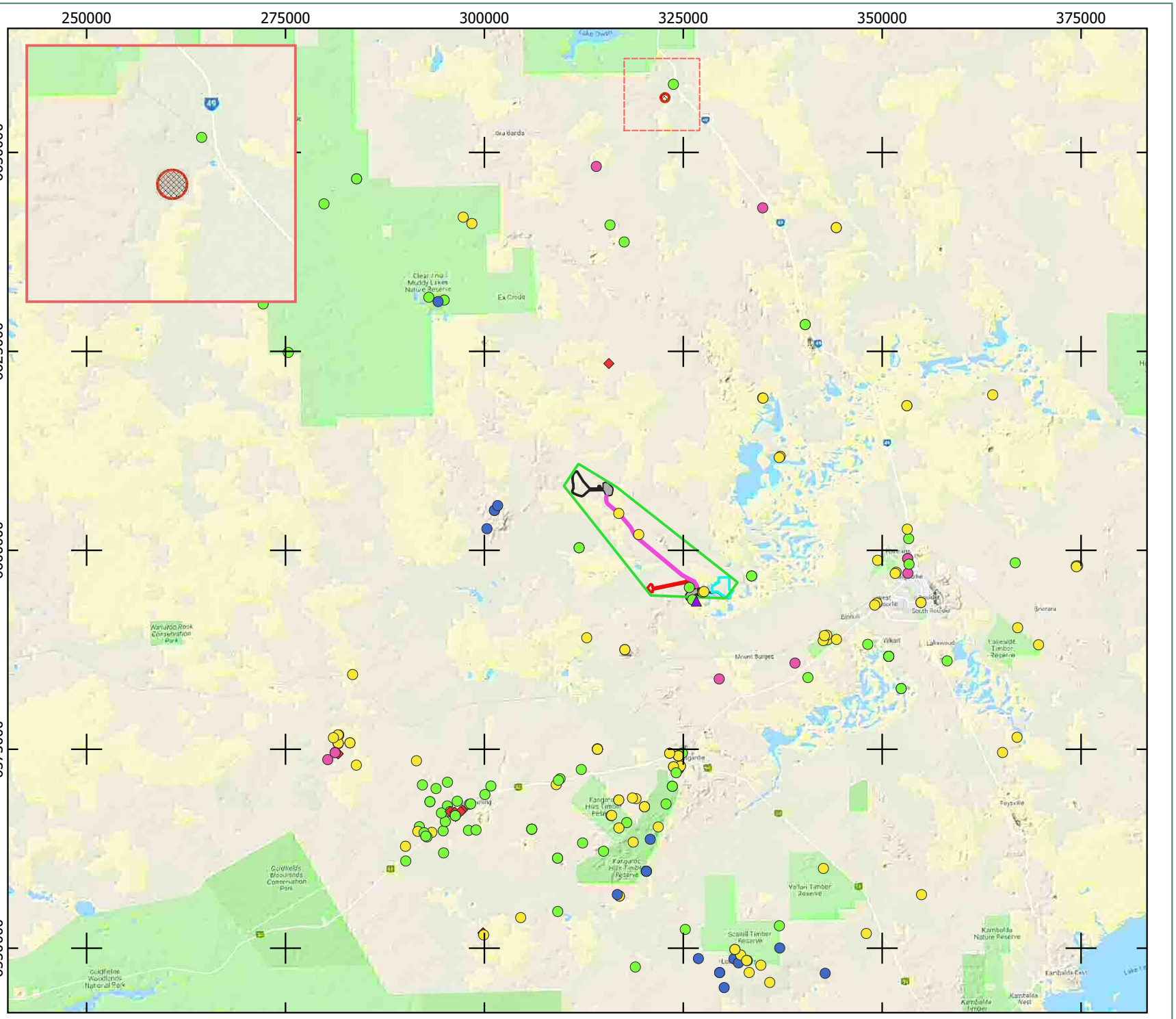
Likelihood	Status	Species
Recorded	Priority 1	*Calandrinia* sp ?*lefroyensis/quartzitica, Eremophila praecox*
	Priority 3	*Allocasuarina eriochlamys* subsp. *grossa*
High	Priority 3	*Austrostipa blackii*
	SOI^	*Calandrinia* sp. Gypsum (F. Obbens & L. Hancock FO 10/14)
	Priority 4	*Eucalyptus jutsonii* subsp. *jutsonii*
Medium	Threatened	*Conostylis lepidospermoides, Gastrolobium graniticum*
	Priority 1	*Acacia websteri, Rhodanthe uniflora, Thryptomene* sp. *Londonderry* (R.H. Kuchel 1763)
	Priority 2	*Elachanthus pusillus*
	Priority 3	*Chrysocephalum apiculatum* subsp. *norsemanense, Notisia intonsa, Phlegmatospermum eremaeum*
	Priority 4	*Eremophila caerulea* subsp. *merrallii*
Low	Priority 1	*Acacia coatesii, Acacia epedunculata, Acacia sclerophylla* var. *teretiuscula, Austrostipa* sp. *Carlingup Road* (S. Kern & R. Jasper LCH 18459), *Dampiera plumosa, Eremophila xantholaema, Eucalyptus websteriana* subsp. *norsemanica, Lepidosperma* sp. *Parker Range* (N. Gibson & M. Lyons 2094), *Melichrus* sp. *Coolgardie* (K.R. Newbey 8698), *Phebalium appressum, Philotheca pachyphylla, Ptilotus chortophytus, Ptilotus procumbens, Ricinocarpos sp. Eastern Goldfields* (A. Williams 3), *Thryptomene* sp. *Coolgardie* (E. Kelso s.n. 1902), *Xanthoparmelia subbarbatica*
	Priority 2	*Austrostipa* sp. *Dowerin* (G. Wiehl F 8004), *Eucalyptus educta, Goodenia salina, Hakea rigida, Lepidium merrallii, Phebalium clavatum, Rumex crystallinus*
	Priority 3	*Acacia crenulata, Acacia cylindrica, Alyxia tetanifolia, Angianthus prostratus, Atriplex lindleyi* subsp. *conduplicata, Calytrix creswellii, Cyathostemon verrucosus, Diocirea acutifolia, Diocirea microphylla, Eleocharis papillosa, Eremophila veronica, Gompholobium cinereum, Grevillea georgeana, Hysterobaeckea ochropetala* subsp. *cometes, Isolepis australiensis, Lepidium*

Likelihood	Status	Species
		fasciculatum, Melaleuca coccinea, Rinzia triplex, Styphelia sp. Bullfinch (M. Hislop 3574), *Xanthoparmelia dayiana*
	Priority 4	*Eucalyptus* x *brachyphylla, Frankenia glomerata, Myriophyllum petraeum*

^ = species of interest

1.8.1.2. Vegetation

One Priority 3 PEC was recorded as occurring within 49 km north of the study area: Emu Land System. The threat to this PEC is listed as 'over grazing' (DBCA 2017). The location and extent of this PEC is mapped on Map 1.4. The Emu land system is described as fresh or brackish ephemeral lakes and swamps; Lignum, Canegrass and Paperbark shrublands. No TECs were mapped in the vicinity of the study areas.



Legend

Database Search Area

PEC database search results

Study Areas

Burgundy Mine & Cutters Ridge

Burgundy to Cutters Ridge Haul Road

Castle Hill study area

Rajax Mine study area

TSF 3 & 4

Significant Flora

Threatened

Priority 1

Priority 2

Priority 3

Priority 4

SOI

N

Scale 1:650000

5 0 5 km

@ A4

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: AH Approved: DC Date: 25-09-2019

Significant Flora and PECs Recorded from the Database Searches

Rayjax to Castle Hill

Map 1.4

Prepared for
Evolution Mining

1.8.2. Fauna Database Searches

A desktop review of all relevant and available vertebrate fauna data sources was undertaken prior to the field survey. The following data sources were searched to assess the vertebrate fauna species likely to occur in the study area:

- DBCA Threatened and Priority Fauna database search (DBCA ref.: FAUNA#6050, 50 km buffer);
- DBCA and WA Museum NatureMap online database (40 km radius);
- EPBC Protected Matters search tool (40km radius); and
- Previous survey reports supplied by the client.

Details of each database search and previous survey report are summarised in Table 1.7.

Table 1.7: Details of Fauna Desktop Assessment

Data Source	Custodian	Details
Commonwealth Protected Matter Search Tool (PMST)	Department of the Environment and Energy (DoEE)	Date: 30/8/19 Buffer: 50 km
NatureMap	Department of Parks and Wildlife / Western Australian Museum	Date: 17/7/19 Buffer: 40 km Centre Point: 121°06'24"E 30°43'54"S
DBCA Threatened Database Search	Department of Biodiversity Conservation and Attraction	Date: 1/8/19 Details: Polygon plus 50 km
Western Australian Museum	Arachnida & Myriapoda Database	Search Area: NW corner -30.236° 120.609° SE corner -31.128° 121.67°
	Crustacea Database	
	Mollusc Database	
Phoenix (2019) Mungari Gold Operations Cutters Ridge	Evolution Mining Ltd	Level 1 Fauna survey at Cutters Ridge
Harewood (2014a) Burgundy Project Area	Phoenix Gold Ltd	Level 1 Fauna survey at Burgundy Project
Harewood (2014b) Burgundy Project Area (Mining Lease 16/199, 16/200, 16/527)	Phoenix Gold Ltd	Targeted Malleefowl survey at Burgundy Project
Terrestrial Ecosystem (2016) Mungari Tailing Storage Facility Cell 3	Native Vegetation Solutions	Level 1 Fauna survey at TSF Cell 3

A preliminary assessment of each significant species identified in the above database searches was completed prior to undertaking the field survey, with the following information provided:

- Conservation status (EPBC Act, WC Act, DBCA listing);
- Description of species habitat requirements and presence of this habitat within the study area;
- Summary of relevant records including source of record (DBCA, previous report etc.) and accuracy of the record location; and
- Likelihood of occurrence criteria assigned and justification of likelihood of occurrence that considers known habitats, survey effort etc. The likelihood of occurrence was determined based on the criteria outlined in Table 1.8.

Table 1.8: Likelihood of Occurrence Criteria – Vertebrate Fauna

Likelihood	Criteria
Recorded	Species recorded in the study area in the previous ten years.
High	Species recorded within or in close proximity to study area within 20 years. Suitable habitat occurs in the study area
Medium	Species recorded within or in close proximity to study area within 20 years. Species recorded outside the study area but within 50°km. Suitable habitat occurs in the study area.
Low	Species or community rarely or not recorded within 20°km of the study area. Suitable habitat does not occur within or in close proximity to the study area.
Very Low	Species not recorded within 50° km despite multiple recent surveys. Suitable habitat does not occur within the study area. Species considered locally extinct.

The results of the literature review identified fauna species that are listed under the current legislative framework. Three conservation lists have been developed at Commonwealth (EPBC Act) and State level (BC/WC Act and DBCA priority list).

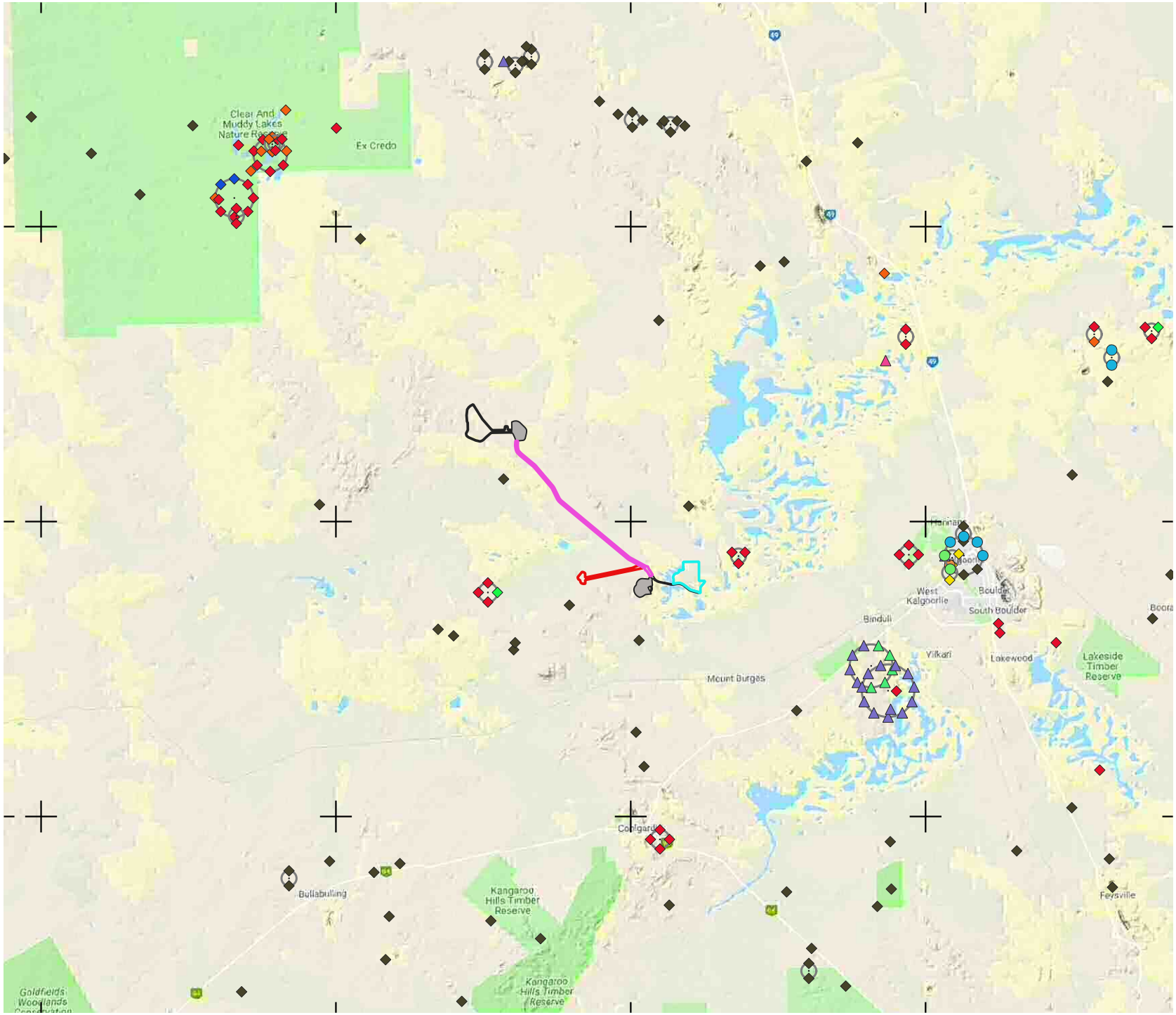
The literature review includes 24 conservation significant fauna species recorded from within the wider region. These are listed in Table 1.9 and mapped on Map 1.5. Survey techniques were tailored to those conservation significant species potentially occurring within the study area. Suitable habitat for each species was assessed and mapped across the extent of the study areas.

Table 1.9: Significant Fauna Recorded from the Database Searches

Likelihood of Occurrence	Fauna Taxa	Conservation Status			Database Record
		EPBC Act	BC Act	DBCA	
Mammals					
Low	Numbat (*Myrmecobius fasciatus*)	EN	EN	EN	NatureMap, PMST, DBCA
	Greater Bilby *(Macrotis lagotis)*	VU	VU	VU	NatureMap, PMST, DBCA
	Chuditch (*Dasyurus geoffroii*)	VU	VU	VU	PMST
	Western False Pipistrelle (*Falsistrellus mackenziei*)	-	-	P4	DBCA
Birds					
High	Malleefowl *(Leiopa ocellata)*	VU	VU	-	NatureMap, PMST
Medium	Carnaby's Cockatoo *(Calyptorhynchus latirostris)*	EN	EN	-	NatureMap, DBCA
	Peregrine Falcon (*Falco peregrinus*)	-	OS	-	NatureMap, DBCA
Low	Curlew Sandpiper *(Calidris ferruginea)*	CR	CR	-	NatureMap, PMST
	Night Parrot (*Pezoporus occidentalis*)	EN	EN	-	PMST
	Fork-tailed Swift (*Apus pacificus*)	M	M	-	PMST
	Common Sandpiper (*Actitis hypoleucos*)	M	M		NatureMap, PMST, DBCA
	Common Greenshank (*Tringa nebularia*)				NatureMap, PMST, DBCA
	Sharp-tailed Sandpiper (*Calidris acuminata*)				NatureMap, DBCA
	Wood Sandpiper (*Tringa glareola*)				NatureMap, DBCA
	Ruddy Turnstone (*Arenaria interpres*)				DBCA
	Red-necked Stint (*Calidris ruficollis*)				NatureMap, DBCA

Likelihood of Occurrence	Fauna Taxa	Conservation Status			Database Record
		EPBC Act	BC Act	DBCA	
	Glossy Ibis (*Plegadis falcinellus)*				DBCA
	Sanderling (*Calidris alba)*				DBCA
	Grey-tailed Tattler (*Tringa brevipes*)				NatureMap, DBCA
	Oriental Plover (*Charadrius veredus*)				NatureMap, DBCA
	Hooded Plover (*Thinornis rubicollis*)	-	-	P4	NatureMap, DBCA
	Blue-billed Duck (*Oxyura australis*)	-	-	P4	NatureMap, DBCA
Birds					
Medium	Arid Bronze Azure Butterfly *(Ogyris subterrestris petrina)*	CR	CR	-	NatureMap, DBCA
	Inland Hairstreak (*Jalmenus aridus*)	-	-	P1	NatureMap, DBCA

Following the survey, this preliminary list of significant fauna species was then re-assessed based on the findings during the survey.



Legend

Study Areas

- Burgundy Mine & Cutters Ridge
- Burgundy to Cutters Ridge Haul Road
- Castle Hill study area
- Rajax Mine study area
- TSF 3 & 4

Database Search results

- Mammal - EN
- Mammal - VU
- Mammal - P4
- Bird - CR & IA
- Bird - EN
- Bird - VU
- Bird - IA
- Bird - OS
- Bird - P4
- Invert - CR
- Invert - P1
- Invert - P3

N

5 0 5 km

Scale 1:450000 @ A4

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: AH Approved: DC Date: 25-09-2019

Significant Fauna Recorded from the Database Searches

Rayjax to Castle Hill

Map 1.5

Prepared for Evolution Mining

1.8.3. SRE Species Status and Database Searches

The SRE status of taxa collected is based on categories which were developed by the Western Australian Museum (WAM; Table 1.10). The categories are used by taxonomists and consultants in order to describe the SRE status of taxa collected from the study area. The classifications listed in Table 1.10 are based on known information of the species group such as distribution, representation of records in collections, and distinct morphological features. Information gaps lead to classing taxa as potential SREs which is a requirement under the precautionary principle.

Table 1.10: Western Australian Museum SRE categories (2013)

Distribution	Taxonomic Certainty	Taxonomic Uncertainty
Distribution <10,000km^2	• Known distribution of <10,000km^2 • Taxonomy is well known • Group is well represented in collections and /or via comprehensive sampling Confirmed SRE	• Patchy sampling has resulted in incomplete knowledge of the geographic distribution of the group • There is incomplete taxonomic knowledge • The group is not well represented in collections This category is most applicable to situations where there are gaps in knowledge of the taxon Potential SRE
Distribution >10,000km^2	• Known distribution of >10,000km2 • Taxonomy is well known • Group is well represented in collections and /or via comprehensive sampling Widespread (not SRE)	

The database searches returned 11 spiders from four families, five millipedes from one family, one isopod, two butterflies from one family, two pseudoscorpions from two families, one scorpion, and three snails from three families (Table 1.9). The two butterflies are significant and one is listed under the EPBC Act/BC Act (*Ogyris subterrestris petrina*) and one as a Priority 1 by the DBCA (*Jalmenus aridus*). They were also returned from the database searches described in section 1.8.2. Of the remaining 23 SRE invertebrate species, 12 are potential SRE species and 11 are confirmed SRE species (Table 1.9).

Table 1.11: Significant Fauna Recorded During the Database Searches

Order/Family	Fauna Taxa	Closest Record Location	SRE Category
Araneae (Spiders)			
Actinopodidae	*Missulena harewoodi*	20km E of Kalgoorlie	Potential
Barychelidae	*Idiommata* 'kalgoorlie'	12km E of Kalgoorlie	Potential
Ctenizidae	*Conothele* 'MYG549'	Rowles	Confirmed
	Conothele 'MYG554'	14km of Kalgoorlie, Ora Banda	Confirmed
Idiopidae	*Idiosoma* 'MYG244'	Rowles Lagoon NR	Confirmed
	Idiosoma `kalgoorie'	20km E of Kalgoorlie	Potential
	Idiosoma `goldfields sp. group`	Kalgoorlie	Potential
	Proshermacha 'MYG435'	Credo Station	Potential
	Proshermacha 'MYG345'	Credo Station	Potential
	Proshermacha 'MYG441'	Credo Station	Potential
	Teyl 'MYG412'	Credo Station	Potential
Diplopoda (Millipedes)			
Paradoxosomatidae	*Antichiropus* 'broad arrows'	23km E of Kalgoorlie	Confirmed

Order/Family	Fauna Taxa	Closest Record Location	SRE Category
	Antichiropus 'DIP065'	Binduli	Confirmed
	Antichiropus 'DIP067'	23km E of Kalgoorlie	Confirmed
	Antichiropus 'kalgoorlie'	Binduli	Confirmed
	Antichiropus nadinae	Credo Station	Confirmed
Crustaceaa			
Armadillidae	*Buddelundia frontosa*	Binduli, Helena Aurora Range	Potential
Lepidoptera (Butterflies and Moths)			
Lycaenidae	*Jalmenus aridus*	Lake Douglas (1980-1990)	Possible / DBCA Priority 1
	Ogyris subterrestris petrina	Lake Douglas (1986)	Confirmed / EPBC Vulnerable
Pseudoscorpiones (Pseudoscorpions)			
Chthonioidea	Austrochthonius `sp. indet. or sp. nov?`	Binduli	Potential
Garypoidea	*Synsphyronus* `PSE025`	Credo Station	Potential
Scorpiones (Scorpions)			
Buthidae	Isometroides `n. sp.`	Credo Station	Potential
Gastropoda (Snails)			
Cameinidae	*Sinumelon* cf. *jimberlanensis*	35km SE of Coolgardie, Dundas Rock, Norseman	Confirmed
Pupillidae	*Pupilla* cf. *ficulnea*	Credo Station	Confirmed
Succineidae	*Succinea aridicola*	Boulder	Confirmed

2. METHODOLOGY

2.1. Field Survey Timing

The survey was undertaken from 19 - 25 August 2019 by two Spectrum personnel; Senior Zoologist, Astrid Heidrich and Botanist, Carmel Forrester (12 person days).

To characterise the prevailing conditions of the survey, monthly rainfall data was sourced from the nearest Bureau of Meteorology (BOM) station (Kalgoorlie-Boulder Airport BOM station # 12038), for the 12 months prior to the survey and compared to the sum of the long-term median rainfall (1939-2019). This is displayed in Figure 2.1.

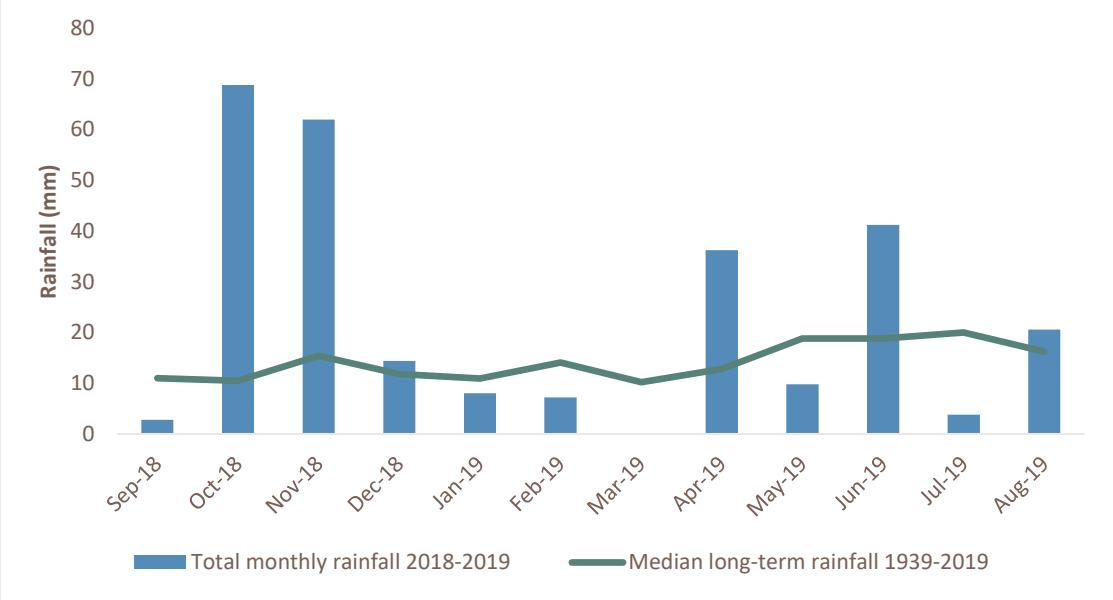


Figure 2.1: Rainfall 12 Months Preceding the Survey at Kalgoorlie-Boulder Airport Weather Station

The following rainfall was recorded at the Kalgoorlie-Boulder Airport BOM station (Bureau of Meteorology, 2019):

- In the 12 months preceding the 2019 field survey (September 2018 to August 2019), 275mm of rainfall was recorded, which is 104 mm higher than the sum of the long-term annual median of 171 mm; and
- In the three-month period prior to the survey (June- August 2019), 66 mm of rainfall was recorded, which is 11 mm higher than the sum of the long-term annual median for the same three months (55 mm).

The survey was undertaken following a period of above median rainfall, and growth conditions for the survey were likely to have been optimal. The Coolgardie Bioregion is considered part of the Interzone Botanical province where recommendations are to conduct flora and vegetation surveys are in Spring, from September to November (EPA, 2016). The field survey timing was conducted outside of EPA recommended timing, however there was above average rainfall and many species were flowering/fruiting during the assessment and it is unlikely to have affected the results of the assessment.

2.2. Project Team and Licences

Spectrum Ecology staff involved with this assessment are listed in Table 2.1, along with their role, years of experience and relevant licences.

Table 2.1: Project Team and Licences

Staff	Role	Years of Experience	Licences
Carmel Forrester	Botanist	5 years	FB82 000 134
Astrid Heidrich	Zoologist	11 years	BA27 000 104

2.3. Reconnaissance Flora and Vegetation Assessment

2.3.1. Field Methodology and Sampling Effort

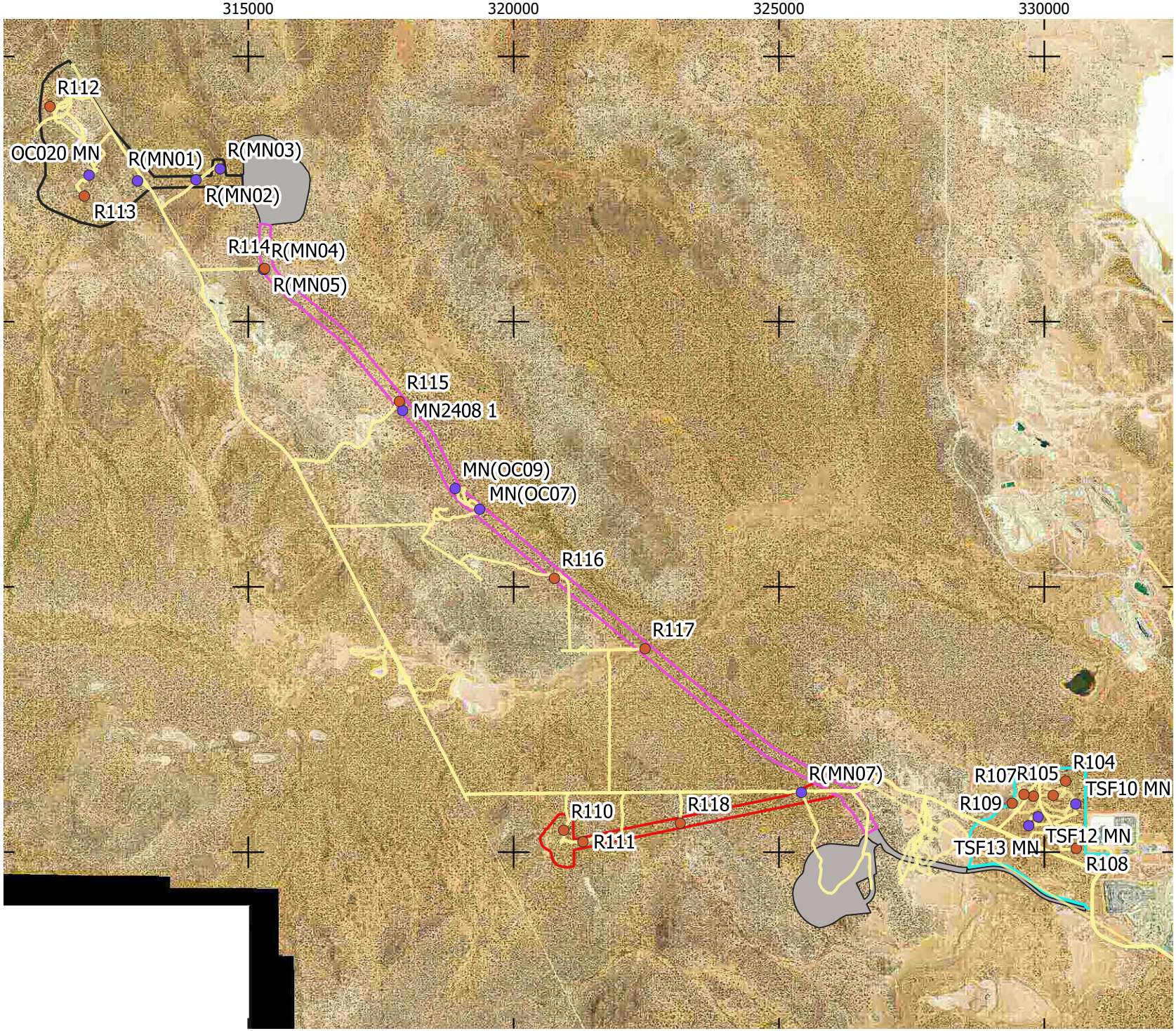
A Reconnaissance level flora and vegetation assessment was conducted at the study areas. This was considered appropriate as it is the preliminary investigation into environmental values of the study area and some of the study areas and surrounding areas have been previously assessed at a detailed flora and vegetation level (Burgundy Mine, Cutters Ridge Mine and TSF area).

A combination of relevés, traverses and opportunistic sampling is appropriate for reconnaissance level surveys as stipulated in the guidance statement (EPA, 2015) and these survey techniques are described in Table 2.2. Comprehensive relevé data collection information is included in Appendix B. Information on vegetation mapping was collected at selected sites and also opportunistically whilst traveling through the study areas. During the survey, 15 relevés were sampled within the study area including two relevés and four mapping sites at Castle Hill, three relevés and one mapping site in Rayjax, four relevés and five mapping sites in Burgundy to Cutters Ridge Haul Road, and six relevés and three mapping sites in the TSF area (site information is described in Appendix C). Relevés, mapping sites, traverses and vehicle tracks are mapped in Map 2.1.

Table 2.2: Reconnaissance Flora and Vegetation Assessment Survey Techniques

Survey Technique	Description
Relevés	Relevés are a low intensity survey technique for gathering information for low-intensity flora and vegetation surveys. Information collected at each relevé includes: • Site code, date, location, botanist; • A photograph; • Vegetation condition and disturbances (including fire); • Landform including; slope, soil, rock type, aspect; and • Flora and vegetation information; dominant cover, structure and species count where necessary.
Traverses	A traverse is an unmarked route along which data is collected. Traverses are useful for identifying the boundaries and characteristics of vegetation types, selecting sites for detailed survey, and targeting significant flora or vegetation. Information recorded along a traverse is as for the relevé, with the addition of noting vegetation changes and relationships between vegetation and substrate.
Opportunistic Sampling	Flora and vegetation not recorded through other sampling methods was opportunistically sampled as encountered in the study area. Opportunistic sampling also included recording locations of significant, introduced (weed) and unknown species.
Targeted Sampling	Areas likely to support significant flora or vegetation were targeted during the survey. Including areas with existing records of significant flora (see Section 1.8.1). Areas were selected based on existing records from database searches, geology, vegetation mapping and known Environmentally Sensitive Areas. Where possible, unusual and restricted geological features within the study area were sampled.

	When potentially significant flora were encountered during the survey, sufficient information was recorded to complete a Threatened and Priority Flora Report Form (TPRF).



Legend

Relevés and Mapping Note sites

- Notes
- Releve
- Survey Track files

Study Areas

- Burgundy and Cutters Ridge
- Burgundy to Cutters Ridge Haul Road
- Castle Hill study area
- Rajax study area
- TSF 3 & 4

N

Scale 1:100000

1 0 1 2 km

@ A4

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: AH Approved: DC Date: 25-09-2019

Flora and Vegetation – Sampling Effort at the Study Areas

Rayjax to Castle Hill

Map 2.1

Prepared for
Evolution Mining

2.3.2. Data for the Index of Biodiversity Survey's for Assessments (IBSA)

The Environmental Protection Authority has given instruction that all biological surveys collecting data on biodiversity submit the report and associated raw data to IBSA as an IBSA data package.

All survey data for the study areas has been provided electronically with this report to comply with IBSA data package standards.

2.3.3. Vegetation and Condition Mapping

The data collected from relevés, traverses, as well as general field notes, observations and aerial photography were used to map the vegetation across the study areas. Vegetation was classified structurally based on the dominant species. The vegetation classification is consistent with NVIS Level V – association vegetation descriptions (referred to as a 'vegetation unit' for the local scale in this report). This level of description provides information on the dominant growth form, height and cover for up to three species for each of the upper, mid and ground strata (ESCAVI, 2003).

Vegetation condition was recorded at relevés and where areas of different vegetation condition were observed from both ground truthing and aerial imagery. The vegetation condition was mapped across the study area at the same scale as the vegetation mapping. Vegetation condition ratings follow the scale recommended for the interzone botanical province (EPA 2016b), summarised in Table 2.3.

Table 2.3: Vegetation Condition Scale and Criteria

Vegetation Condition	Disturbance Criteria
Pristine	Pristine or nearly so, no obvious signs of disturbance or damage caused by human activities since European settlement.
Excellent	Vegetation structure intact, disturbance affecting individual species. Damage to trees caused by fire, the presence of non-aggressive wees and occasional vehicle tracks.
Very Good	Vegetation structure altered with obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback logging and/or grazing.
Good	Vegetation structure significantly altered by obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration bit not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation is no longer intact, that eh area is completely or almost completely without native species. These areas are often described as "parkland cleared" with the flora comprising weed or crop species with isolated native trees and shrubs.

2.3.4. Nomenclature, Specimen Identification and Lodgement

Flora nomenclature used in this report is consistent with the Western Australian Herbarium's plant census, provided on FloraBase (Western Australian Herbarium, 2019) and is current at the time of report preparation.

Flora specimens were collected of any suspected or known significant flora and to confirm species recorded during the relevés for vegetation mapping. Specimens were identified using the appropriate taxonomic keys and where required, relevant taxonomic experts at the Western Australian Herbarium.

Specimens are vouchered with the Western Australian Herbarium as per guidance; when they represent new populations of threatened or priority flora, new occurrences of TECs or PECs, individuals that have atypical characteristics, or bioregional range extensions.

2.3.5. Significant Flora and Vegetation Definitions

Flora and vegetation can be considered significant for a range of reasons.

Significant flora can include:

- Being identified as threatened (state listed WC Act and/or nationally listed EPBC Act);
- Being identified as priority species: Priority 1 to 4 (DPaW, 2017);
- Locally endemic or association with a restricted habitat type (e.g. surface water or groundwater dependant ecosystems);
- New species or anomalous features that indicate a potential new species;
- Representative of the range of a species (particularly, at the extremes of range recently discovered range extensions, or isolated outliers of the main range);
- Unusual species, including restricted subspecies, varieties or naturally occurring hybrids; and
- Relictual status, being representative of taxonomic groups that no longer occur widely in the broader landscape.

Significant vegetation can include:

- Identified as Threatened Ecological Community (TEC) (state listed WC Act and/or nationally listed EPBC Act);
- Priority Ecological Community (PEC) (DBCA 2017);
- Restricted distribution;
- Degree of historical impact from threatening processes;
- A role as a refuge; and
- Providing an important function required to maintain ecological integrity of a significant ecosystem.

2.3.6. Limitations and Constraints

Survey specific limitations and constraints for the flora and vegetation reconnaissance assessment for the study areas are discussed in Table 2.4.

Table 2.4: Study Limitations and Constraints – Flora

Limitation	Comment
Availability of contextual information at a regional and local scale.	There are no vegetation surveys or datasets available for contextual information to compare Level V vegetation associations at a regional scale. Beard mapping has been used, however this mapping is conducted at a coarse scale (1:250,000) and can only provide an approximate comparison.
Competency/experience of the team carrying out the survey, including experience in the bioregion surveyed.	Botanist Carmel Forrester has 5 years' experience in conducting botanical surveys throughout Western Australia, including experience within the Interzone Botanical Province.
Proportion of flora recorded and/or collected, any identification issues.	Only suspected or known significant and introduced flora, and flora that was part of vegetation communities were collected which is acceptable for a reconnaissance level survey. One *Tecticornia* specimen could not be identified to species level. Plants were identified by taxonomist Udani Sirisena who has botanical and taxonomic experience throughout Western Australia. Where there were complexities specialist taxonomists at the Western Australian herbarium were consulted.

Limitation	Comment
Was the appropriate area fully surveyed (effort and extent).	Prior to the field survey, relevés were selected to represent the diversity of vegetation and geology present at the study area. This was sufficient to map and classify the vegetation of the study area for a reconnaissance level survey. Previous records of priority flora and areas considered potential habitat were targeted where possible. Some areas could not be accessed in the southern area.
Access restrictions within the survey area.	Access was limited in the southern areas.
Survey timing, rainfall, season of survey.	The field survey timing was slightly outside of the appropriate season for a flora and vegetation survey conducted in the Interzone Botanical Province. However, there was higher than average rainfall at the study areas prior to the field survey and this is not considered to have affected the survey results. Survey timing was outside the recommended season for *Calandrinia lefroyensis/quartzitica* which was targeted during a separate assessment and this species will be targeted during an additional survey in October 2019. There was a partial timing constraint due to site HSE requirements; however, the study areas have been adequately assessed at a Reconnaissance level.
Disturbance that may have affected the results of survey such as fire, flood or clearing.	No disturbances were recorded at the study area that have affected the results of the survey. No areas were recently burnt or cleared within the study area.

2.4. Level 1 Fauna Assessment

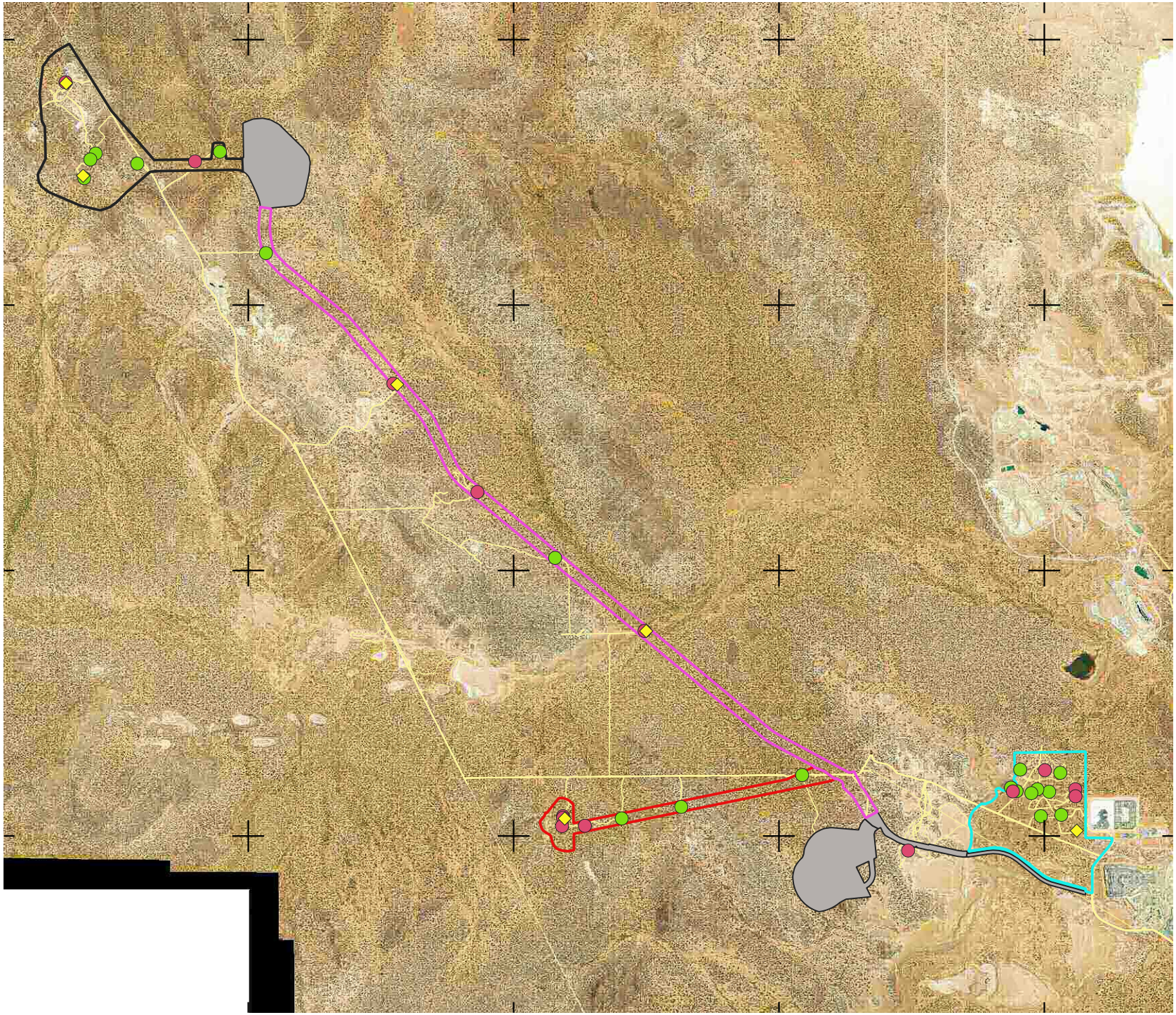
2.4.1. Field Methodology

The terrestrial vertebrate fauna survey was carried out in accordance with Technical Guidance: Terrestrial Fauna Surveys (EPA 2016e), Technical Guidance: Sampling of short range endemic invertebrate fauna (EPA 2016c) and Technical Guidance: Sampling Methods for Terrestrial Vertebrate Fauna (EPA 2016d). The guidance suggests selective low-intensity sampling of fauna and fauna habitats to verify the accuracy of the desktop assessment. The approach of a Level 1 fauna survey was used to describe and map the vertebrate fauna habitats across the study area and complete active searches to describe the vertebrate fauna assemblages of the study area, particularly any significant fauna identified as likely to be present.

A total of eight survey sites were established at Castle Hill and Haul Road, eight survey sites were established at Rayjax and Haul Road, seven survey sites were installed at Burgundy to Cutters Ridge Haul Road and 14 survey sites were established at the TSF Area (Map 2.2). A variety of survey techniques was used for fauna as outlined in Table 2.5. All survey data has been provided electronically with this report as an IBSA data package.

Table 2.5: Fauna Survey Techniques

Fauna	Survey Technique
Mammals	Direct sightings and indirect evidence such as tracks, scats and diggings were recorded across the study area.
Birds	Direct sightings and calls, as well as indirect evidence such as feathers, pellets and nests were recorded across the study area. Search effort was focused to Malleefowl in areas potentially suitable for those species.
Reptiles & Amphibians	Direct sightings and indirect evidence such as calls, tracks, diggings and skins were recorded across the study area and targeted searches were undertaken in areas with suitable habitat.
Invertebrate Fauna	Foraging methods included raking in leaf litter, and searching under bark, under shrubs and moist soil. Leaf litter collections were also made from selected sites and samples placed under Tullgren funnels in the laboratory.



Legend

Study Areas

- Burgundy Mine
- Burgundy to Cutters Ridge Haul Road
- Castle Hill study area
- Cutters Ridge
- Rajax Mine study area
- TSF 3 & 4

Fauna Sites Locations

- Active Search
- Habitat Assessment
- Leaf litter collection
- Survey Track files

N

1 0 1 2 km

Scale 1:100000 @ A4

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: AH Approved: DC Date: 18-09-2019

Fauna – Sampling Effort at the Study Areas

Rayjax to Castle Hill

Map 2.2

Prepared for
Evolution Mining

2.4.2. Fauna Habitat Mapping

Fauna habitat mapping identifies areas of vegetation and land features that are distinguishable from other areas. Typically, each fauna habitat supports a characteristic fauna assemblage that is adapted to the features of the fauna habitat. Fauna habitat types are identified and mapped based on the following information:

- General vegetation type (Shepherd, Beeston and Hopkins, 2001);
- Vegetation Types mapped within the study area;
- Vegetation structure;
- Landforms;
- Geological units;
- Soil substrate;
- Aerial imagery;
- Fauna assemblage; and
- Field observations.

The fauna habitat was recorded at each survey sites and also opportunistically during traversing by foot and travelling between sites.

2.4.3. Nomenclature and Taxonomy

Nomenclature for mammals, reptiles and amphibians followed the Western Australian Museum Checklist of the Vertebrates of Western Australia. Taxonomy of birds followed Christidis and Boles (2008). Fauna species identifications were completed based on information provided in references listed in Table 2.6.

Table 2.6: References Used for Identification of Fauna Species

Fauna	Survey Technique
Mammals	Churchill (2009), Menkhorst and Knight (2001), Van Dyck and Strahan (2008)
Birds	Simpson and Day (2004)
Reptiles & Amphibians	Wilson and Swan (2017), Cogger (2014), Tyler and Doughty (2009)

2.4.4. Conservation Significant Fauna

During the field survey, the preliminary assessment of the likelihood of conservation significant fauna species occurring within the study area was reviewed and amended (see Section 1.8.2). The assessment included the following:

- Suitable fauna habitats recorded from the study area;
- Distribution of previously recorded conservation significant species;
- Frequency of occurrence of conservation significant species in the region;
- Temporal distribution of conservation significant species; and
- Accuracy of record locations, date and source of record (level of reliability).

The likelihood of occurrence of each conservation significant species listed by the database searches was determined based on the criteria outlined in Table 1.8.

2.4.5. Limitations and Constraints

Survey specific limitations and constraints for the level 1 fauna assessment conducted at the study areas are discussed in Table 2.7.

Table 2.7: Limitations and Constraints – Fauna

Limitation	Constraint	Comment
Competency/experience of the consultant carrying out the survey.	No	Fauna survey staff had relevant experience surveying the south-west and interior regions of Western Australia.
Scope (what faunal groups were sampled and were some sampling methods not able to be employed because of constraints such as weather conditions).	No	Sampling techniques were adequate surveying the study area. All fauna groups were sampled. No constraints were experienced completing the survey.
Proportion of fauna identified, recorded and/or collected.	No	All vertebrate fauna species encountered were identified in the field. Level 1 survey methods do not require the identification of all fauna species present within the study area.
Sources of information.	No	There is a number of surveys previously completed partially inside the study areas and the surroundings. Database searches have captured a relatively large number of species from the area and provide an adequate level of information.
The proportion of the task achieved and further work which might be needed.	No	All components of a level 1 fauna survey were completed.
Timing/weather/season/cycle.	Partially	Low overnight temperatures limited the activity level of vertebrate fauna species, in particular reptile species. This was reflected in a relatively low count of reptile species recorded during the survey. However, the assessment of fauna habitats and recording of secondary evidence of fauna species was not compromised. All dominant fauna groups and assemblages were recorded.
Disturbances (e.g. fire, flood, accidental human intervention) which affected results of survey.	No	No disturbances were recorded during the survey.
Intensity (in retrospect, was the intensity adequate).	No	A level 1 survey was adequate to identify faunal assemblages and fauna habitat present within the study areas. Targeted searches for significant fauna species were not completed across all sections of the study area and are recommended.
Completeness (was the relevant area fully surveyed.	No	All representative habitat types were surveyed for habitats and faunal assemblage.
Resources (degree of expertise available in animal identification to taxon level).	No	Resources available were adequate and did not compromise the outcome of the survey.
Remoteness and/or access problems.	No	Some access restrictions were experienced within the study areas and some remote areas were not accessed; however, level 1 fauna sampling was completed at representative habitats.
Availability of contextual (e.g. biogeographic) information on the region.	No	Background information about the region was available and sufficient.

3. RESULTS

3.1. Flora

A total of 113 taxa from 28 families and 49 genera were recorded during the survey and these are listed in Appendix D. Of these, one was an introduced species; **Erodium cicutarium*. No Threatened flora taxa were recorded. Significant and introduced flora information is detailed for each project area below. Another species, Priority 3; *Allocasuarina eriochlamys* subsp. *grossa* was recorded from outside the study areas.

3.1.1. Castle Hill

No Threatened, Priority, or other significant flora taxa were recorded at the Castle Hill study area. No introduced flora species were recorded.

3.1.2. Rayjax

No Threatened, Priority, or other significant flora taxa were recorded at the Rayjax study area. No introduced flora species were recorded.

3.1.3. Burgundy to Cutters Ridge Haul Road

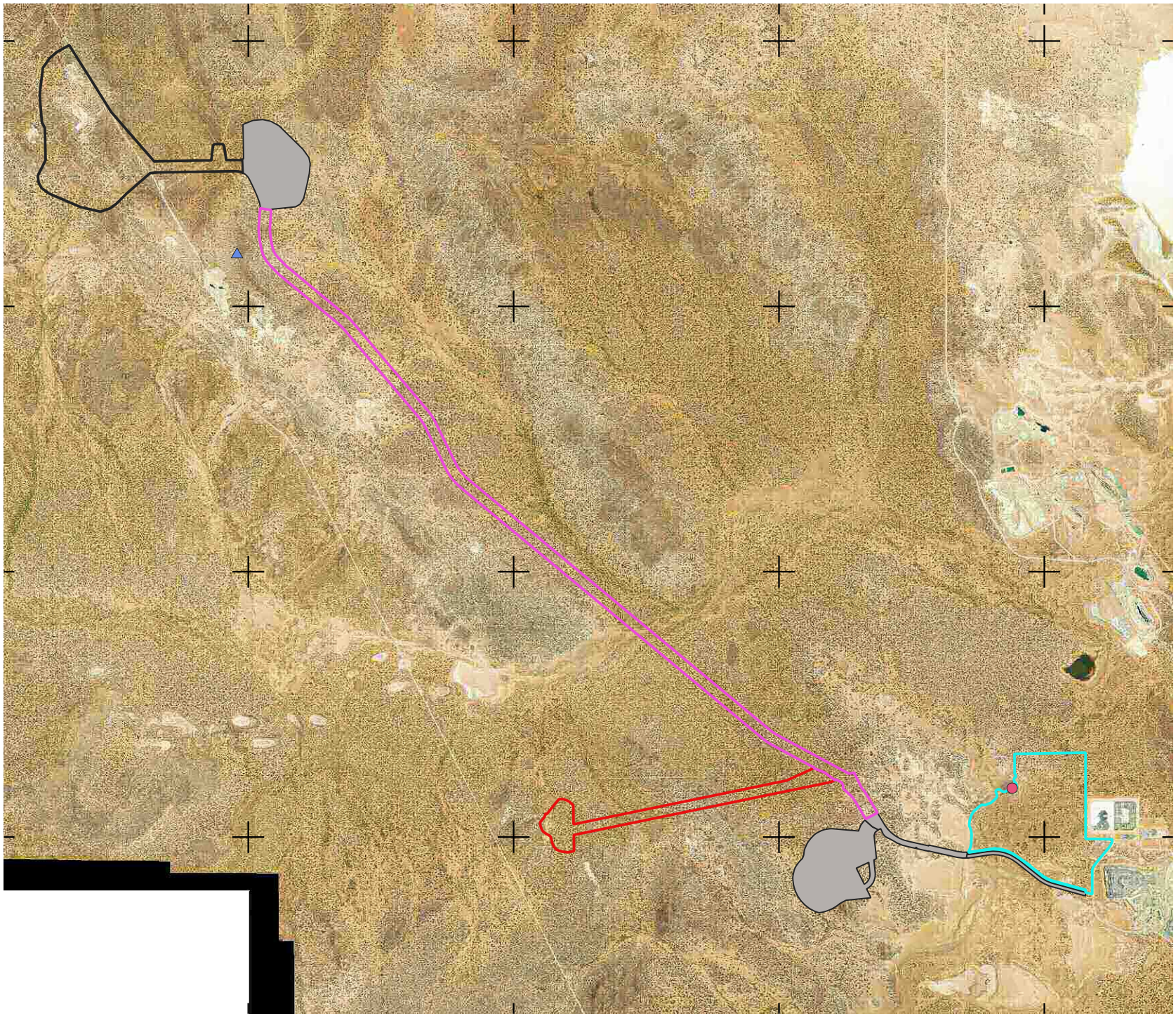
One Priority 3 species, *Allocasuarina eriochlamys* subsp. *grossa* (Figure 3.1) was opportunistically recorded at one location, 480 m west of the Burgundy to Cutters Ridge Haul Road study area. It was recorded on a lateritic outcrop and the population formed the dominant tall shrub stratum (10% cover). The location is mapped on Map 3.1 and coordinates have been provided electronically. No Threatened or other significant flora taxa were recorded from inside the Burgundy to Cutters Ridge Haul Road study area. There were no introduced flora species recorded.

Figure 3.1 : *Allocasuarina eriochlamys* subsp. grossa

3.1.4. TSF

No Threatened, Priority or other significant flora taxa were recorded at the TSF study area.

One environmental weed species was recorded at R109: **Erodium cicutarium*, approximately 20 m outside the TSF study area. This was recorded at one location (0.1% cover), and the location is shown on Map 3.1.



Legend

Study Area

- Burgundy & Cutters Ridge
- Burgundy to Cutters Ridge Haul Road
- Castle Hill study area
- Rajax Mine study area
- TSF 3 & 4

Significant and Introduced Flora

- Allocasuarina eriochlamys
- Erodium cicutarium

N

Scale 1:100000 @ A4

1 0 1 2 km

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: AH Approved: DC Date: 26-09-2019

Significant and Introduced Flora Recorded at the Study Areas

Rayjax to Castle Hill

Map 3.1

Prepared for
Evolution Mining

3.2. Vegetation

There were eleven vegetation types described throughout the study areas occurring on flat plains, claypans, minor drainage lines, simple slopes, and minor floodplains:

i: *Eucalyptus campaspe* and *E. salmonophloia* mid open woodland over *Atriplex nummularia* ssp. *spathulata* and *Eremophila interstans* ssp. *interstans* mid sparse shrubland over *Atriplex vesicaria* low sparse shrubland;

ii: *Tecticornia halocnemoides* ssp. *halocnemoides*, *T. indica* ssp. *indica* and *T. chartacea* low open chenopod shrubland;

iii: *Eucalyptus yilgarnensis*, *E. salubris* and *E. clelandiorum* mid woodland over *Eremophila scoparia*, *Senna artemisiodes* ssp. *filifolia* mid open shrubland over *Ptilotus obovatus* low isolated shrubs;

iv: *Eucalyptus salubris*, *E. clelandiorum* (+/-*E. salmonophloia*) mid open woodland over *Eremophila scoparia* and *Senna artemisiodes* ssp. *filifolia* mid open shrubland over *Atriplex* sp. and *Olearia muelleri* low open shrubland;

v: *Casuarina pauper* low isolated trees over *Melaleuca laterifora* mid open shrubland over *Frankenia setosa* and *Atriplex stipitata* low open shrubland;

vi: *Eucalyptus moderata*, *Eucalyptus oleosa* and *E. torquata* tall mallee woodland over *Eremophila pustulata* and *Eremophila interstans* ssp. *interstans* tall sparse shrubland over *Acacia erinacea*, *Senna artimisioides* ssp. f*ilifolia*, and *Atriplex vesicaria* low sparse shrubland;

vii: *Eucalyptus griffithsii* low woodland over *Senna artemisioides* and *Eremophila ionantha* mid sparse shrubland over *Acacia hemiteles* and *Grevillea acuaria* low sparse shrubland;

viii: *Eucalyptus griffithsii* low woodland over *Eremophila scoparia*, *E. interstans* ssp. *virgata* and *Acacia hemiteles* mid to tall open shrubland;

ix: *Eucalyptus clelandiorum* tall mallee woodland over *Eremophila scoparia*, *Acacia burkittii* and *Atriplex nummularia* ssp. *spathulata* low sparse shrubland;

x: *Eucalyptus griffithsii* low isolated trees over *Acacia burkittii*, *Eremophila scoparia* and *Atriplex nummularia* ssp. *spathulata* mid to tall open shrubland; and

xi: *Duma florulenta* mid sparse shrubland.

Table 3.1 outlines each of the vegetation types and details which type was present in each study area. Vegetation is described for each study area in the sections overleaf.

Table 3.1: Vegetation Types Recorded at the Study Areas

Unit	Description	Landform, Soil & Geology	Sites	Area (ha)					Representative Photograph
				Castle Hill	Rayjax	Haul Road	TSF	Total	
i	*Eucalyptus campaspe* and *E. salmonophloia* mid open woodland over *Atriplex nummularia* ssp. *spathulata* and *Eremophila interstans* ssp. *interstans* mid sparse shrubland over *Atriplex vesicaria* low sparse shrubland	Flat Plain Red Sand; Clay	R112	130.97	-	-	-	130.97	
ii	*Tecticornia halocnemoides* ssp. *halocnemoides*, *T. indica* ssp. *indica* and *T. chartacea* low open chenopod shrubland	Flat Claypan Red Cracking Clay	R107	-	-	-	24.90	24.90	
iii	*Eucalyptus yilgarnensis*, *E. salubris* and *E. clelandiorum* mid woodland over *Eremophila scoparia*, *Senna artemisiodes* ssp. *filifolia* mid open shrubland over *Ptilotus obovatus* low isolated shrubs	Flat Plain Red Sand; Clay	R108 TSF13 MN	-	-	-	9.50	9.50	

Unit	Description	Landform, Soil & Geology	Sites	Area (ha)					Representative Photograph
				Castle Hill	Rayjax	Haul Road	TSF	Total	
iv	*Eucalyptus salubris*, *E. clelandiorum* (+/-*E. salmonophloia*) mid open woodland over *Eremophila scoparia* and *Senna artemisiodes* ssp. *filifolia* mid open shrubland over *Atriplex* sp. and *Olearia muelleri* low open shrubland ^Priority species found within this vegetation type	Flat Plain Red Sand; Clay	R104 TSF10 MN TSF12 MN R110 R111 MN04 R115 R114 R115 R116	5.76	131.70	344.40	96.25	578.11	
v	*Casuarina pauper* low isolated trees over *Melaleuca lateriflora* mid open shrubland over *Frankenia setosa* and *Atriplex stipitata* low open shrubland	Minor Floodplain Red Sand; Clay	R105 R106	-	-	-	292.40	292.40	
vi	*Eucalyptus moderata*, *Eucalyptus oleosa* and *E. torquata* tall mallee woodland over *Eremophila pustulata* and *Eremophila interstans* ssp. *interstans* tall sparse shrubland over *Acacia erinacea*, *Senna artimisioides* ssp. *filifolia*, and *Atriplex vesicaria* low sparse shrubland	Simple Slope Red Brown Sand; Clay	R118	-	15.19	-	-	15.19	

Unit	Description	Area (ha)						Representative Photograph
		Landform, Soil & Geology	Sites	Castle Hill	Rayjax	Haul Road	TSF	Total	
vii	*Eucalyptus griffithsii* low woodland over *Senna artemisioides* and *Eremophila ionantha* mid sparse shrubland over *Acacia hemiteles* and *Grevillea acuaria* low sparse shrubland	Flat Minor Drainage Red Orange Sand; Clay	R117	-	-	9.78	-	9.78	
viii	*Eucalyptus griffithsii* low woodland over *Eremophila scoparia, E. interstans* ssp. *virgata* and *Acacia hemiteles* mid to tall open shrubland	Flat Plain Red Sand; Clay	R(MN03)	15.24	-	-	-	15.24	
ix	*Eucalyptus clelandiorum* tall mallee woodland over *Eremophila scoparia, Acacia burkittii* and *Atriplex nummularia* ssp. *spathulata* low sparse shrubland	Minor Floodplain Red Sand; Clay	R113	98.00	-	-	-	98.00	

Unit	Description	Landform, Soil & Geology	Sites	Area (ha)					Representative Photograph
				Castle Hill	Rayjax	Haul Road	TSF	Total	
x	*Eucalyptus griffithsii* low isolated trees over *Acacia burkittii*, *Eremophila scoparia* and *Atriplex nummularia* ssp. *spathulata* mid to tall open shrubland	Flat Minor Drainage Red Sand; Clay	R(MN01) R(MN02) OC020 MN	202.80	-	-	-	202.80	
xi	*Duma florulenta* mid sparse shrubland * Weed species found within this vegetation type	Flat Claypan Light Orange Claypan	R109	-	-	-	1.23	1.23	

3.2.1. Castle Hill

Five vegetation types (i, iv, viii, ix and x) were described for the Castle Hill study area derived from flat plains, flat minor drainage and floodplains (see Table 3.1 and Map 3.2).

i: *Eucalyptus campaspe* and *E. salmonophloia* mid open woodland over *Atriplex nummularia* ssp. *spathulata* and *Eremophila interstans* ssp. *interstans* mid sparse shrubland over *Atriplex vesicaria* low sparse shrubland;

iv: *Eucalyptus salubris*, *E. clelandiorum* (+/-*E. salmonophloia*) mid open woodland over *Eremophila scoparia* and *Senna artemisiodes* ssp. *filifolia* mid open shrubland over *Atriplex* sp. and *Olearia muelleri* low open shrubland;

viii: *Eucalyptus griffithsii* low woodland over *Eremophila scoparia*, *E. interstans* ssp. *virgata* and *Acacia hemiteles* mid to tall open shrubland;

ix: *Eucalyptus clelandiorum* tall mallee woodland over *Eremophila scoparia*, *Acacia burkittii* and *Atriplex nummularia* ssp. *spathulata* low sparse shrubland; and

x: *Eucalyptus griffithsii* low isolated trees over *Acacia burkittii*, *Eremophila scoparia* and *Atriplex nummularia* ssp. *spathulata* mid to tall open shrubland.

3.2.1.1. Significant Vegetation

There were no vegetation types that were identified as a TEC/PEC, or significant due to historical impact from threatening processes, or provide a function to maintain ecological integrity of a significant ecosystem.

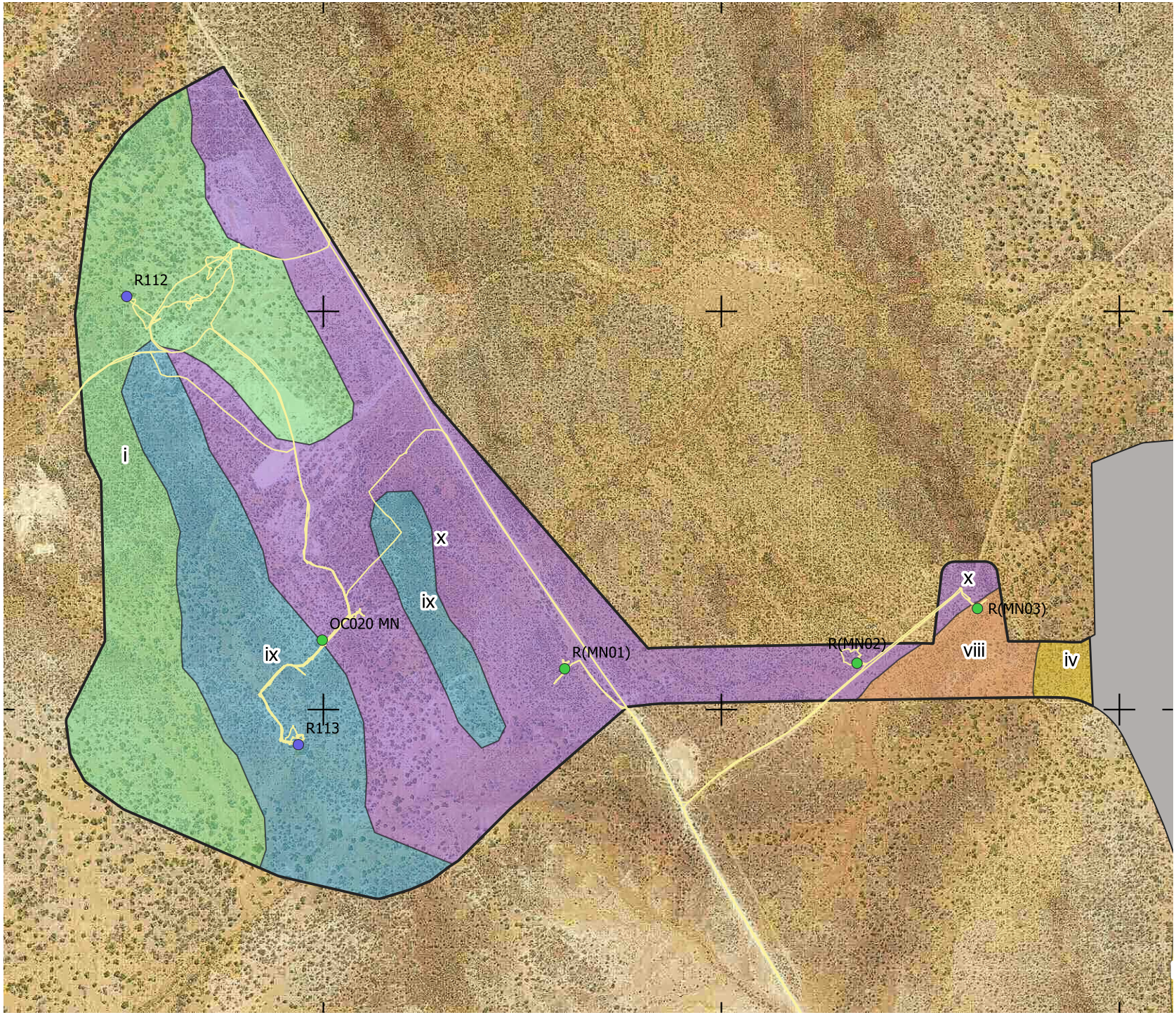
Vegetation type iv is the known habitat for Priority 1 species *Eremophila praecox* and is therefore considered significant as it plays a role in refugee. Vegetation type viii is restricted to a minor drainage channel in the Castle Hill study area and therefore considered significant.

3.2.1.2. Vegetation Condition

Vegetation condition at the Castle Hill study area is presented in Table 3.2 and mapped in Map 3.2. This study area had areas of substantial clearing (9.9%) and the presence of an old mine in the northern section where the vegetation structure was significantly altered. The eastern and southern parts of the study area were disturbed with vehicle tracks and partial clearing, however the vegetation structure remained mostly intact. A small area (7.3%) in the north-west appeared undisturbed. This study area is the location of the decommissioned Castle Hill mine and disturbances can be attributed to this.

Table 3.2: Vegetation Condition at the Castle Hill Study Area

Vegetation Condition	Area (ha)	% of Study Area	Disturbance Details
Pristine	33.0	7.3	Pristine or nearly so, no obvious signs of disturbance, occasionally some presence of old tracks.
Excellent	374.1	82.8	Vegetation structure intact, disturbance affecting individual species. Clearing for drill pads, lines and vehicle tracks.
Good	44.6	9.9	Vegetation structure completely altered for quarry and significantly altered by obvious signs of drilling and mine activity. Retains basic vegetation structure or ability to regenerate it.



Legend

Study Areas

- Burgundy Mine & Cutters Ridge
- Burgundy & Cutters Ridge

Vegetation Units

- i
- ii
- iii
- iv
- v
- vi
- vii
- viii
- ix
- x
- xi

N

Scale 1:20000 | 0.25 | 0 | 0.25 km | @ A4

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

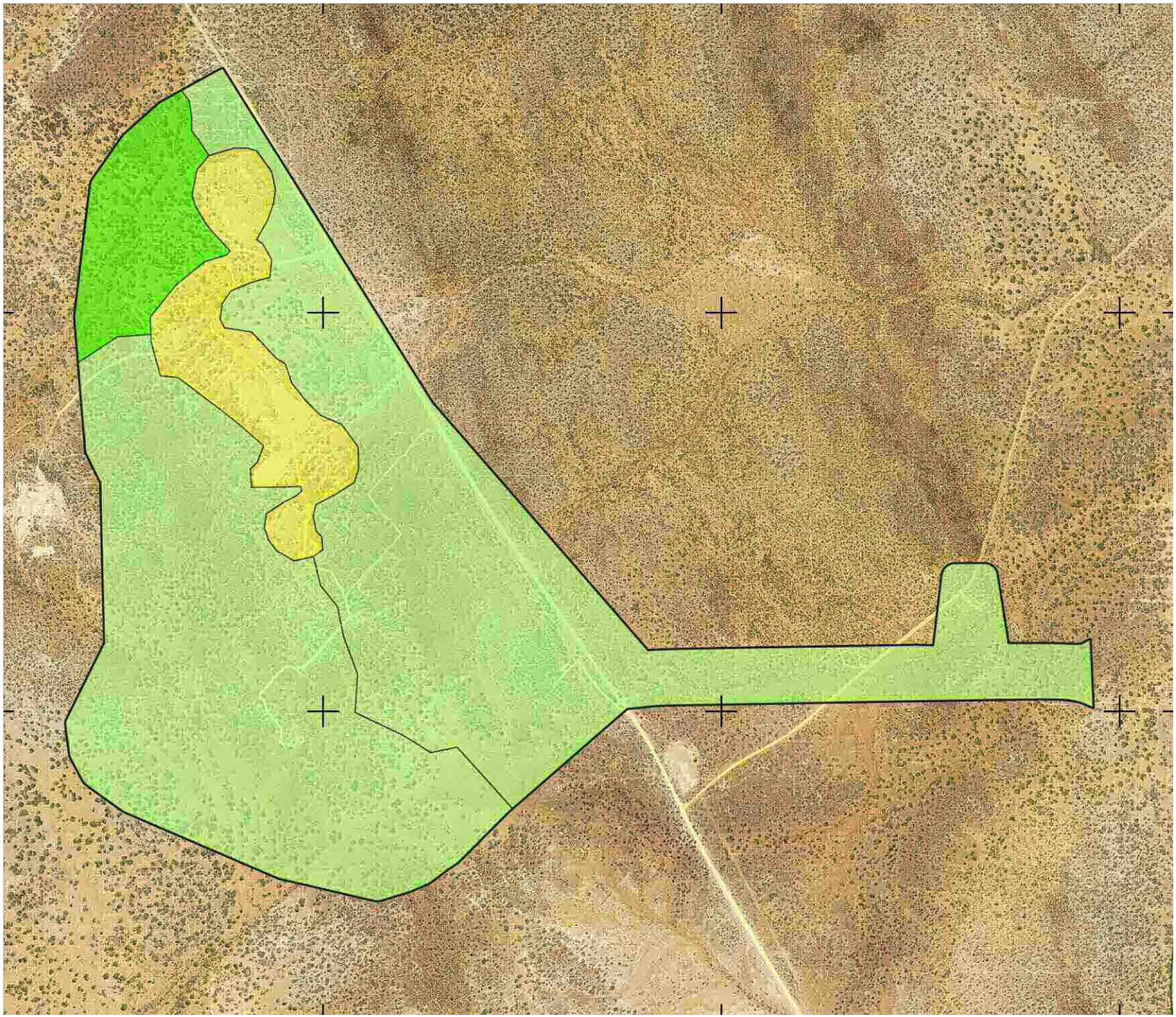
Author: AH Approved: DC Date: 25-09-2019

Vegetation Types Mapped at Castle Hill Study Area

Rayjax to Castle Hill

Map 3.2

Prepared for
Evolution Mining



Legend

Study Area

- Castle Hill study area

Vegetation Condition Mapping

- Pristine
- Excellent
- Good

N

0.25 0 0.25 km

Scale 1:20000 @ A4

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: AH Approved: DC Date: 20-09-2019

Vegetation Condition Mapped at the Castle Hill Study Area

Rayjax to Castle Hill

Map 3.3

Prepared for
Evolution Mining

3.2.2. Rayjax

Two vegetation types (iv and vi) were described for the Rayjax study area and were derived from flat plains, flat minor drainage and floodplains (Map 3.4).

iv: *Eucalyptus salubris*, *E. clelandiorum* (+/-*E. salmonophloia*) mid open woodland over *Eremophila scoparia* and *Senna artemisiodes* ssp. *filifolia* mid open shrubland over *Atriplex* sp. and *Olearia muelleri* low open shrubland; and

vi: *Eucalyptus moderata*, *Eucalyptus oleosa* and *E. torquata* tall mallee woodland over *Eremophila pustulata* and *Eremophila interstans* ssp. *interstans* tall sparse shrubland over *Acacia erinacea*, *Senna artimisioides* ssp. *filifolia*, and *Atriplex vesicaria* low sparse shrubland.

3.2.2.1. Significant Vegetation

There were no vegetation types that were identified as a TEC/PEC or significant due to historical impact from threatening processes, or provide a function to maintain ecological integrity of a significant ecosystem.

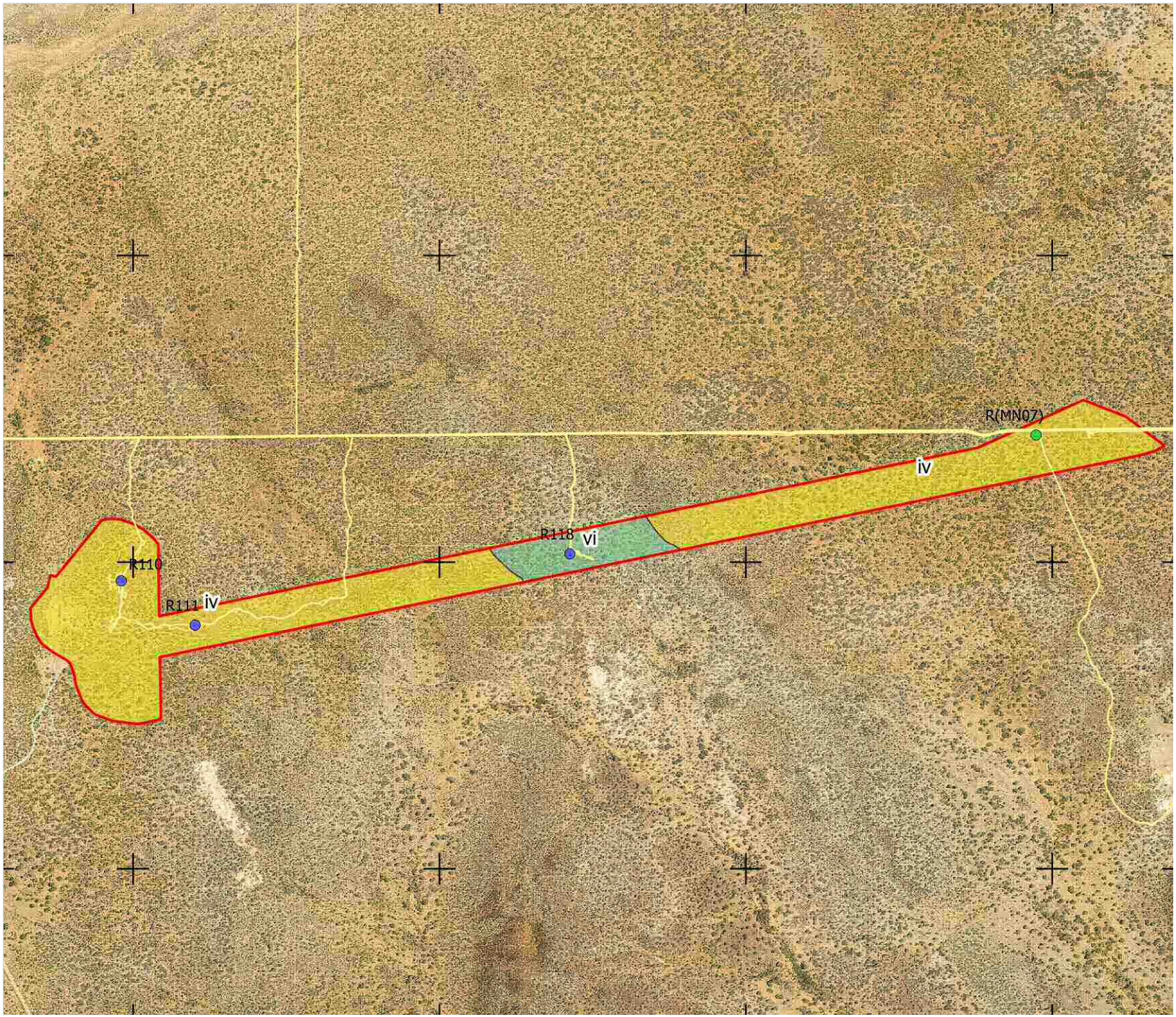
Vegetation type iv is the known habitat for Priority 1 species *Eremophila praecox* and is therefore considered significant as it plays a role in refugee. Vegetation type vi is restricted to a minor drainage channel in the Rayjax study area and therefore considered significant.

3.2.2.2. Vegetation Condition

Vegetation condition in the Rayjax study area is presented in Table 3.3 and mapped in Map 3.5. The Rayjax study area had minor clearing at the western extent (2.6%) where the vegetation structure was significantly altered. Some parts of the study area were disturbed with vehicle tracks, however the vegetation structure remained intact. A large portion (31.1%) appeared undisturbed.

Table 3.3: Vegetation Condition at the Rayjax Study Area

Vegetation Condition	Area (ha)	% of Study Area	Disturbance Details
Pristine	45.8	31.1	Pristine or nearly so, no obvious signs of disturbance, or weeds.
Excellent	97.3	66.2	Vegetation structure intact, disturbance affecting individual species. Clearing for drill vehicle tracks present.
Good	3.9	2.6	Vegetation structure altered for mine activity. Retains basic vegetation structure or ability to regenerate it.



Legend

Study Areas
- Rajax Mine study area
- Burgundy & Cutters Ridge

Vegetation Units
- iv
- vi

Releves and Mapping Sites
- Notes
- Releve
- Tracks and traverses

N

0.25 0 0.25 km

Scale 1:26000 @ A4

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

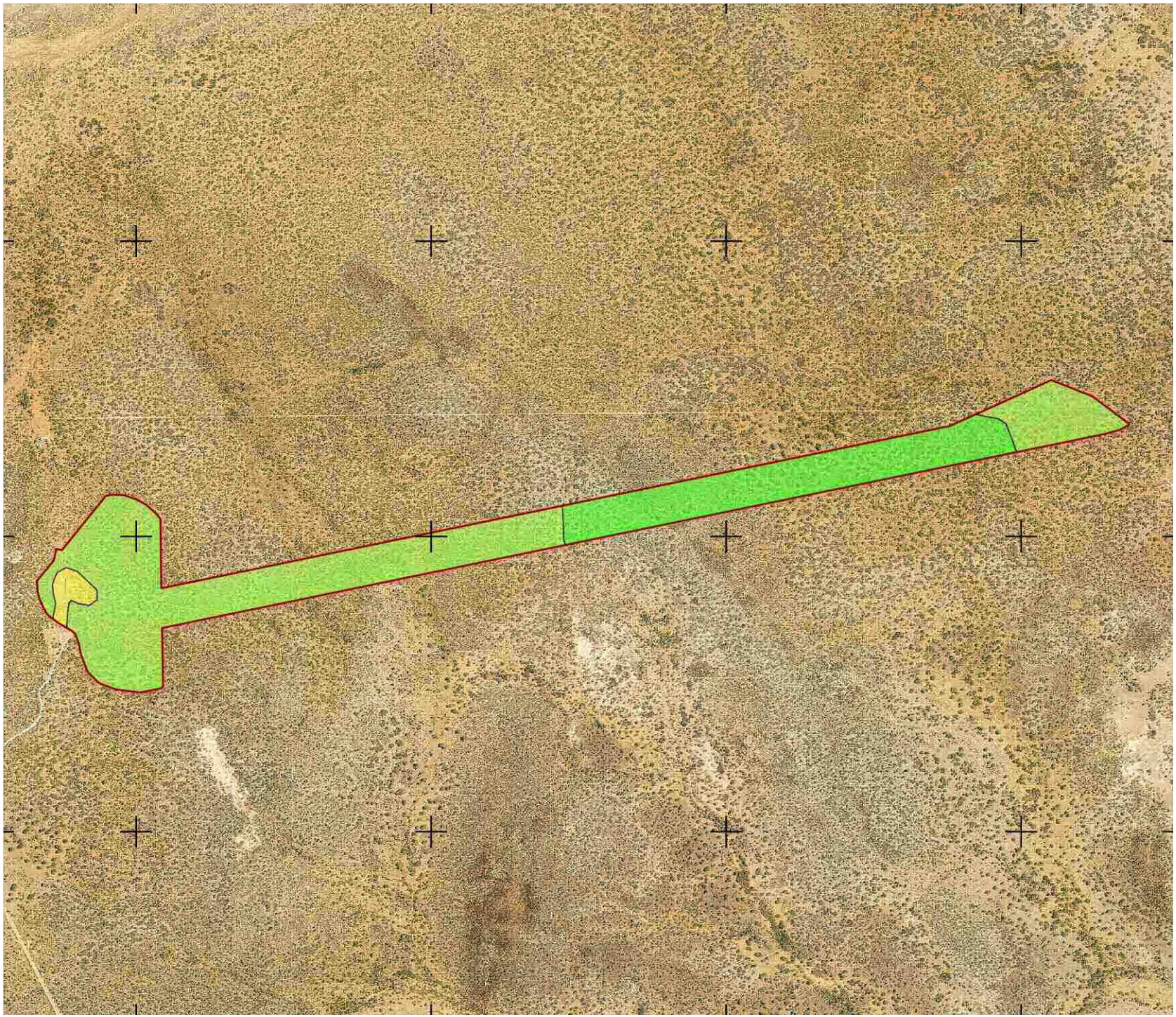
Author: AH Approved: DC Date: 25-09-2019

Vegetation Types Mapped at Rayjax Study Area

Rayjax to Castle Hill

Map 3.4

Prepared for
Evolution Mining



Legend

Study Area

- Rajax Mine study area

Vegetatoin Condition Mapping

- Pristine
- Excellent
- Good

N

0.25 0 0.25 km

Scale 1:27000 @ A4

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: AH Approved: DC Date: 20-09-2019

Vegetation Condition Mapped at the Rayjax Study Area

Rayjax to Castle Hill

Map 3.5

Prepared for
Evolution Mining

3.2.3. Burgundy to Cutters Ridge Haul Road

Two vegetation types (iv, vii) were described for the Burgundy to Cutters Ridge study area and were derived from flat plains, and flat minor drainage (Map 3.6).

iv: *Eucalyptus salubris*, *E. clelandiorum* (+/-*E. salmonophloia*) mid open woodland over *Eremophila scoparia* and *Senna artemisiodes* ssp. *filifolia* mid open shrubland over *Atriplex* sp. and *Olearia muelleri* low open shrubland; and

vii: *Eucalyptus griffithsii* low woodland over *Senna artemisioides* and *Eremophila ionantha* mid sparse shrubland over *Acacia hemiteles* and *Grevillea acuaria* low sparse shrubland.

3.2.3.1. Significant Vegetation

There were no vegetation types that were identified as a TEC/PEC or significant due to historical impact from threatening processes, or provide a function to maintain ecological integrity of a significant ecosystem.

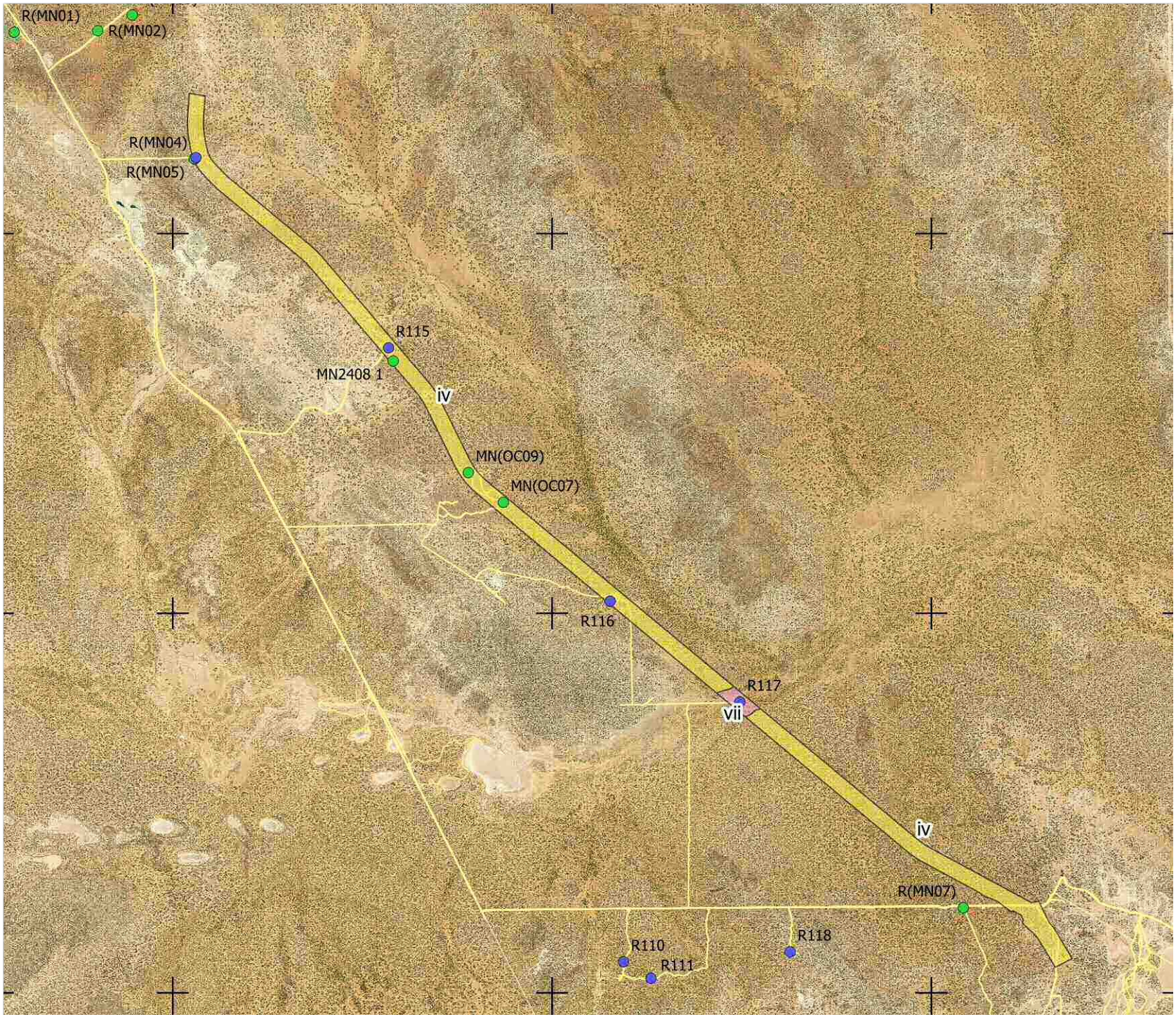
Vegetation type iv is the known habitat for Priority 1 species, *Eremophila praecox*, and is therefore considered significant as it plays a role in refugee. Vegetation type vii is restricted to a minor drainage channel in the Haul Road study area and therefore considered significant.

3.2.3.2. Vegetation Condition

Vegetation condition in the Burgundy to Cutters Ridge Haul Road study area is presented in Table 3.4 and mapped in Map 3.7. This study area was mostly assessed as Pristine with no obvious signs of disturbance. A small percentage in the south had areas disturbed with vehicle tracks, however the vegetation structure remained intact.

Table 3.4: Vegetation Condition at the Burgundy to Cutters Ridge Haul Road Study Area

Vegetation Condition	Area (ha)	% of Study Area	Disturbance Details
Pristine	326.6	92.2	Pristine or nearly so, no obvious signs of disturbance, or weeds.
Excellent	27.6	7.8	Vegetation structure intact, disturbance affecting individual species. Clearing for vehicle tracks present.



Legend

Study Areas

- Burgundy Mine & Cutters Ridge
- Rajax Mine study area
- Burgundy to Cutters Ridge Haul Road
- Burgundy & Cutters Ridge

Vegetation Units

- iv
- vii

Releves and Mapping Sites

- Notes
- Releve
- Tracks and traverses

N

Scale 1:70000 (0.5 0 0.5 1 km) @ A4

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

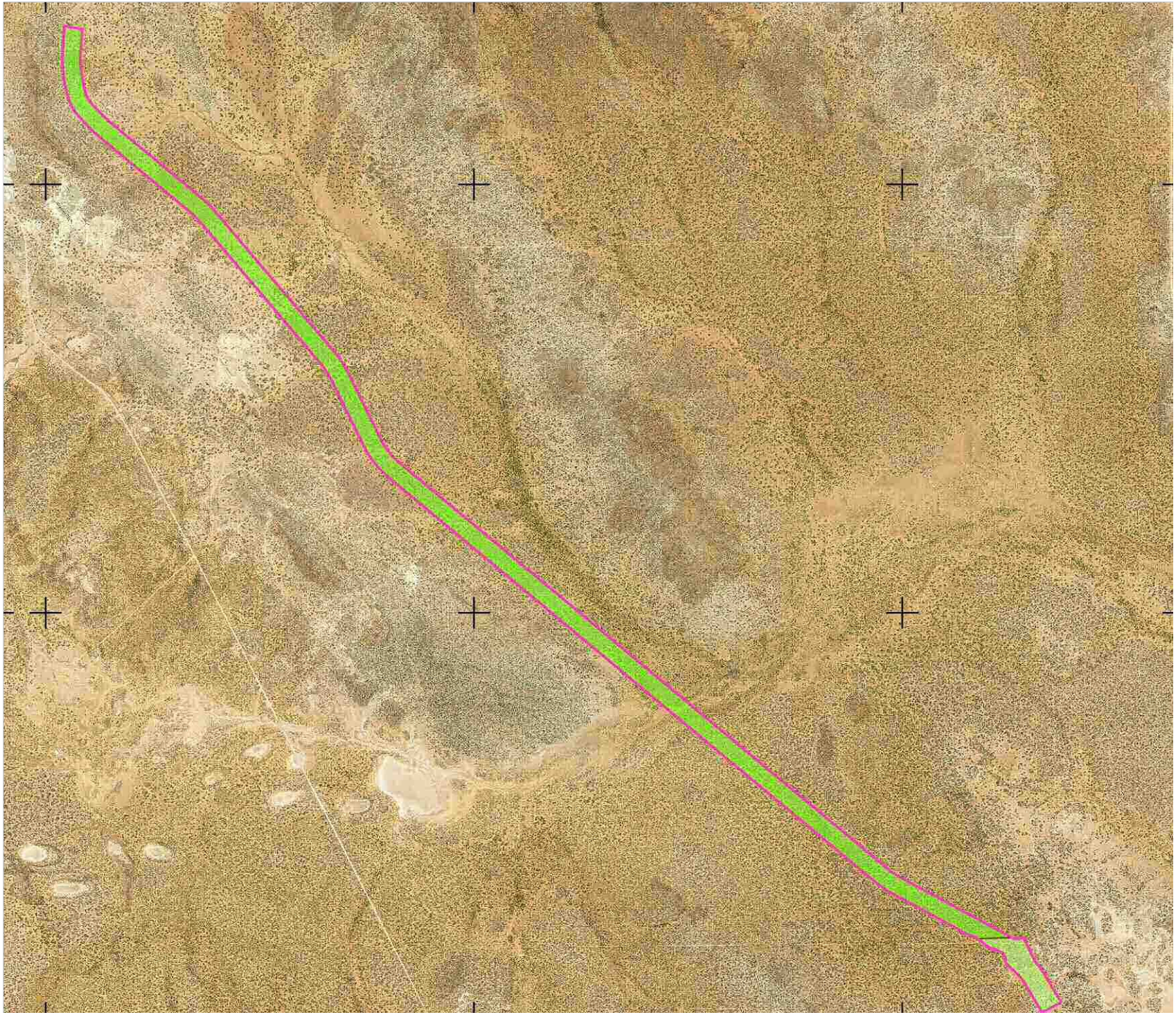
Author: AH Approved: DC Date: 25-09-2019

Vegetation Types Mapped at Burgundy to Cutters Ridge Haul Road Study Area

Rayjax to Castle Hill

Prepared for
Evolution Mining

Map
3.6



Legend

Study Area

- Burgundy to Cutters Ridge Haul Road

Vegetation Condition Mapping

- Pristine
- Excellent

N

0.5 0 0.5 km

Scale 1:62000 @ A4

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: AH Approved: DC Date: 20-09-2019

Vegetation Condition Mapped at Burgundy to Cutters Ridge Haul Road

Rayjax to Castle Hill

Map 3.7

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Evolution Mining

3.2.4. TSF

Five vegetation types (ii, iii, iv, v and xi) were described for the TSF study area and were derived from flat plains, claypans and minor floodplains (see Table 3.1 and Map 3.8).

ii: *Tecticornia halocnemoides* ssp. *halocnemoides*, *T. indica* ssp. *indica* and *T. chartacea* low open chenopod shrubland;

iii: *Eucalyptus yilgarnensis*, *E. salubris* and *E. clelandiorum* mid woodland over *Eremophila scoparia*, *Senna artemisiodes* ssp. *filifolia* mid open shrubland over *Ptilotus obovatus* low isolated shrubs;

iv: *Eucalyptus salubris*, *E. clelandiorum* (+/-*E. salmonophloia*) mid open woodland over *Eremophila scoparia* and *Senna artemisiodes* ssp. *filifolia* mid open shrubland over *Atriplex* sp. and *Olearia muelleri* low open shrubland;

v: *Casuarina pauper* low isolated trees over *Melaleuca laterifora* mid open shrubland over *Frankenia setosa* and *Atriplex stipitata* low open shrubland; and

xi: *Duma florulenta* mid sparse shrubland.

3.2.4.1. Significant Vegetation

There were no vegetation types that were identified as a TEC/PEC or significant due to historical impact from threatening processes, or provide a function to maintain ecological integrity of a significant ecosystem.

Vegetation type iv is the known habitat for Priority 1 species, *Eremophila praecox*, and is therefore considered significant as it plays a role in refuge.

Vegetation types ii and v are known habitat for the Priority 1 species, *Calandrinia lefroyensis*/*C. quartzitica* (taxonomy undetermined), as well as the taxonomically complex and often undescribed *Tecticornia* species and are therefore considered significant as it plays a role in refuge. Vegetation type ii also contains the taxonomically complex and often undescribed *Tecticornia* species and also is considered significant as it plays a role in refuge.

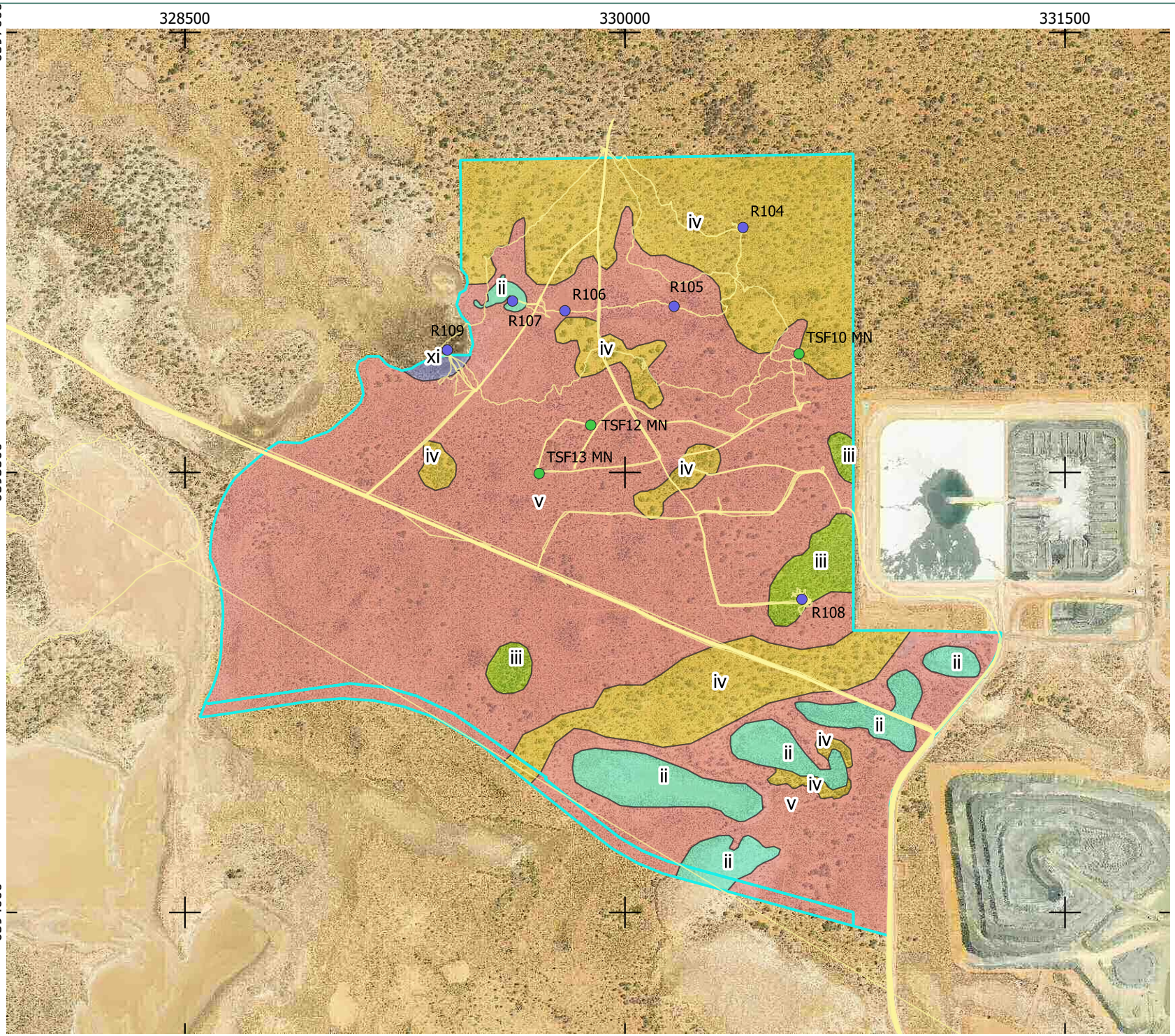
Vegetation types ii, iii and xi are restricted to areas associated with salt lakes in the TSF study area and therefore considered significant.

3.2.4.2. Vegetation Condition

Vegetation condition in the TSF study area is presented in Table 3.5 and mapped in Map 3.9. This study area was disturbed throughout with vehicle tracks and partial clearing for drill pads, however the vegetation structure remained mostly intact. This study area is in close proximity to the existing TSF and active mining Haul Road and the disturbances can be attributed to this.

Table 3.5: Vegetation Condition at the TSF Study Area

Vegetation Condition	Area (ha)	% of Study Area	Disturbance Details
Excellent	425.5	100.0	Vegetation structure intact, disturbance affecting individual species. Clearing for drill pads, lines and vehicle tracks.



Legend

Study Areas

- Burgundy Mine & Cutters Ridge
- Rajax Mine study area
- Burgundy to Cutters Ridge Haul Road
- Burgundy & Cutters Ridge

Vegetation Units

- ii
- iii
- iv
- v
- xi

Releves and Mapping Sites

- Notes
- Releve
- Tracks and traverses

N

0.25 0 0.25 km

Scale 1:18000 @ A4

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: AH Approved: DC Date: 25-09-2019

Vegetation Types Mapped at the TSF Study Area

Rayjax to Castle Hill

Map 3.8

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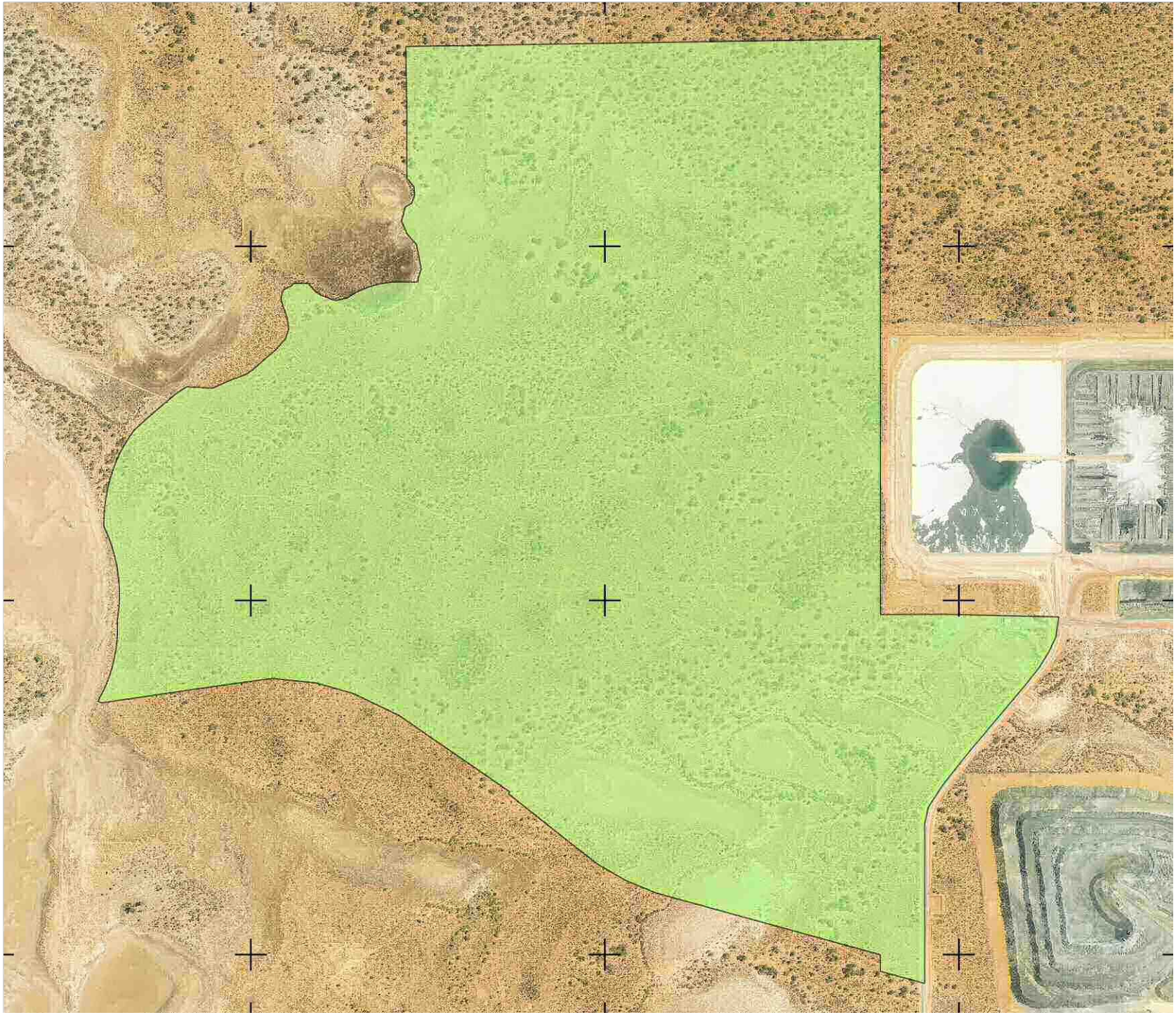


Legend

Study Area

TSF 3 & 4

Vegetation Condition Mapping

Excellent

N

0.2 0 0.2 km

Scale 1:15000 @ A4

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: AH Approved: DC Date: 20-09-2019

Vegtation Condition Mapped at the TSF Area

Rayjax to Castle Hill

Map

Prepared for
Evolution Mining

3.9

3.3. Fauna Habitat

3.3.1. Castle Hill

A total of four fauna habitat types were recorded from the Castle Hill study area. Their extent is listed in Table 3.6 and shown in Map 3.10, and their details are described in the sections below.

Table 3.6: Fauna Habitat Types at the Castle Hill Study Area

Habitat Type	Extent (ha)	% of Study Area	Associated Vegetation Type
Disturbed Eucalypt Woodland	94.4	20.9	Veg type i & x
Gentle Hillslope with Eucalypt Woodland	325.4	72.0	Veg type i, iv, vii, ix & x
Minor Drainage Line	25.9	5.7	Veg type i, vii, ix & x
Open Eucalypt Woodland over Open Tall Shrubs	6.0	1.3	Veg type x

3.3.1.1. Disturbed Eucalypt Woodland over Open Shrubland

The Disturbed Eucalypt Woodland over Open Shrubland was recorded from the northern area of the Castle Hill Mine study area. It covered 94.4 ha which represents 20.9% of the study area (Map 3.10). It was dominated by open eucalypt trees (*Eucalypt campaspe* and E. *salmonophloia*) over a low open shrub layer of *Eremophila interstants* over *Atriplex nummularia* and *Atriplex vesicaria* (Figure 3.2). Leaf litter was plentiful under trees and shrub thickets with some wood litter present. The substrate consisted of loamy clay with a slightly rocky mantle of small pebbles. The habitat type was intersected by previously cleared and disturbed areas which reduces the suitability for fauna due to fragmentation of the habitats. Some areas were rehabilitated.

Figure 3.2: Disturbed Woodland over Open Shrubland Habitat

3.3.1.2. Gentle Hillslope with Eucalypt Woodland

Gentle Hillslope with Open Eucalypt Woodland was the most commonly recorded habitat type from within the Castle Hill study area (Map 3.10). It covered 325.4 ha which represents 72.0% of the study area. It was characterised by rolling hills and hillslopes with an open layer of eucalypt trees *of Eucalyptus campaspe*, *E. griffithsii* and *E. salmonophloia*, and scattered *Casuraina obesa*. The understorey was typically sparse to

moderate and consisted of an open shrublayer of mixed lower shrubs of *Eremophila interstants*, *E. scoparia*, *E. interstans*, *Acacia hemiteles* over *Atriplex nummularia* and *A. vesicaria* (Figure 3.3). The substrate varied between loamy clay without pebbles to a heavier mantle of rocks and pebbles. Woodlitter and leaf litter was present under trees.

Figure 3.3: Gentle Hillslope with Eucalypt Woodland Habitat

3.3.1.3. Minor Drainage Line

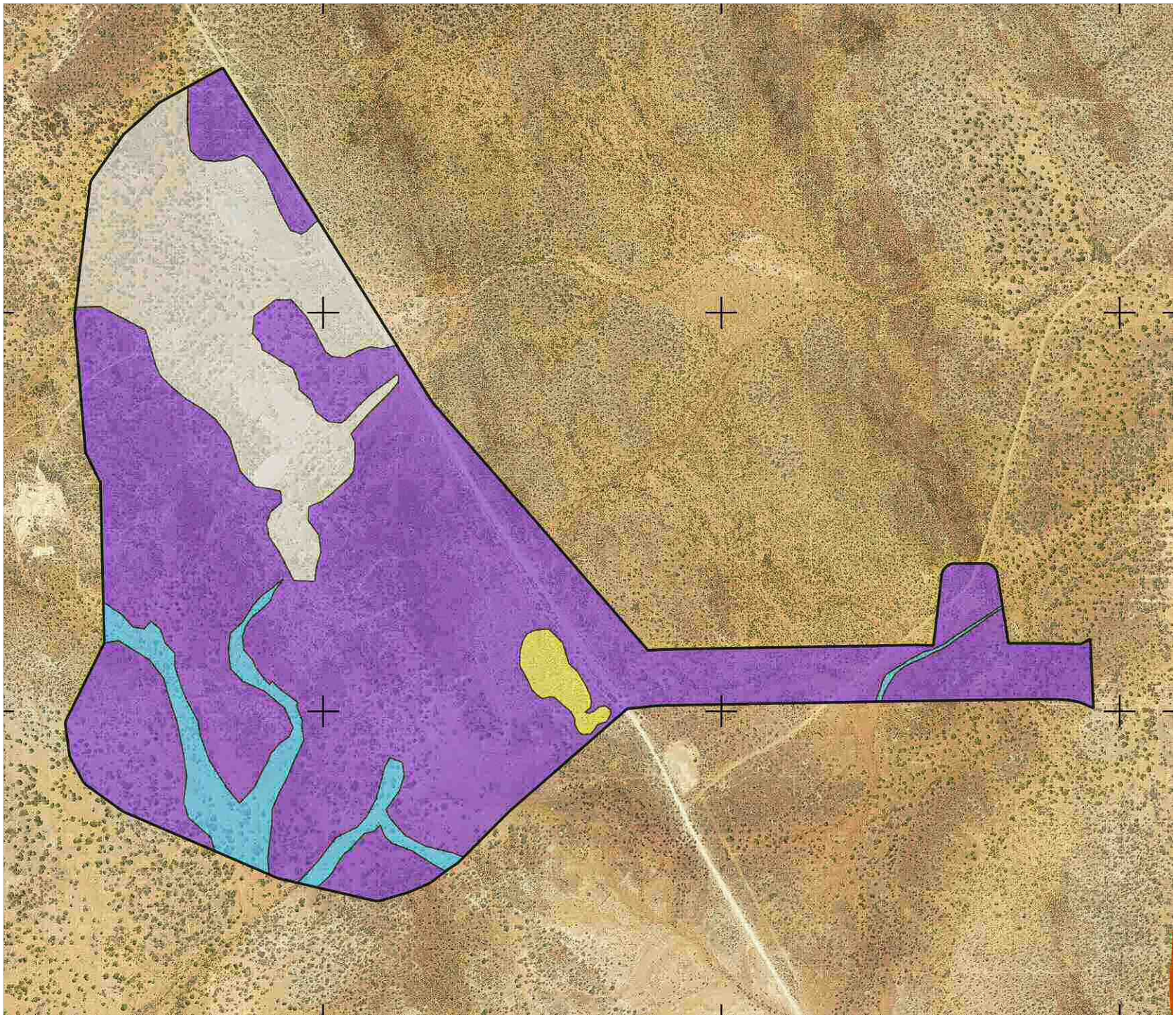
The Minor Drainage Line habitat was recorded from the south-west of the Castle Hill Mine and in the middle of the Haul Road (Map 3.10). It covered 25.9 ha which represents 5.7% of the study area. It is dominated by a very open vegetation layer comprising of fringing *Eucalyptus clelandiorum* over low open shrubs of *Eremophila scoparia*, *Acacia burkitti*, *Acacia tetragonophylla*, and *Atriplex nummularia* (Figure 3.4) Leaf litter was limited to underneath trees along the fringe of the Drainage Line. The substrate consisted of heavy clay with very few rocks.

Figure 3.4: Minor Drainage Line Habitat

3.3.1.4. Open Eucalypt Woodland over Tall Open Shrubs

This habitat type was recorded from the south-east of the Castle Hill Mine study area. It covered 6.0 ha which represent 1.3% of the Castle Hill study area (Map 3.10). The vegetation was dominated by scattered eucalypt trees of *Eucalyptus griffithsii* over an open to moderate layer of tall shrubs (*Acacia burkittii*). There was a lack of lower shrubs, grasses and other ground cover (Figure 3.5). The substrate comprised of heavy clay. Leaf litter was accumulated underneath trees and shrubs. The substrate comprised of heavy clay without rocks or pebbles. Wood litter was very sparse whereas leaf litter was present underneath the shrubs.

Figure 3.5: Open Eucalypt Woodland over Tall Open Shrubs Habitat



Legend

Study Area

- Castle Hill study area

Fauna Habitat Types

- Disturbed Eucalypt Woodland over Open Shrubland
- Gentle Hillslope with Eucalypt Woodland
- Minor Drainage Line
- Open Eucalypt Woodland over Open Tall Shrubs

N

0.25 0 0.25 km

Scale 1:20000 @ A4

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: AH Approved: DC Date: 20-09-2019

Fauna Habitat Types at Castle Hill Study Area

Rayjax to Castle Hill

Map

Prepared for
Evolution Mining

3.10

3.3.2. Rayjax

Two fauna habitats were recorded from the Rayjax study area. Their extent is listed in Table 3.7 and shown in Map 3.11, and their details are described in the sections below.

Table 3.7: Fauna Habitat Types at the Rayjax Study Area

Habitat Type	Extent (ha)	% of Study Area	Associated Vegetation Type
Mixed Eucalypt Woodland	141.9	96.6	Veg type iv
Gentle Hillslope with Eucalypt Woodland	5.0	3.4	Veg type vi

3.3.2.1. Mixed Eucalypt Woodland

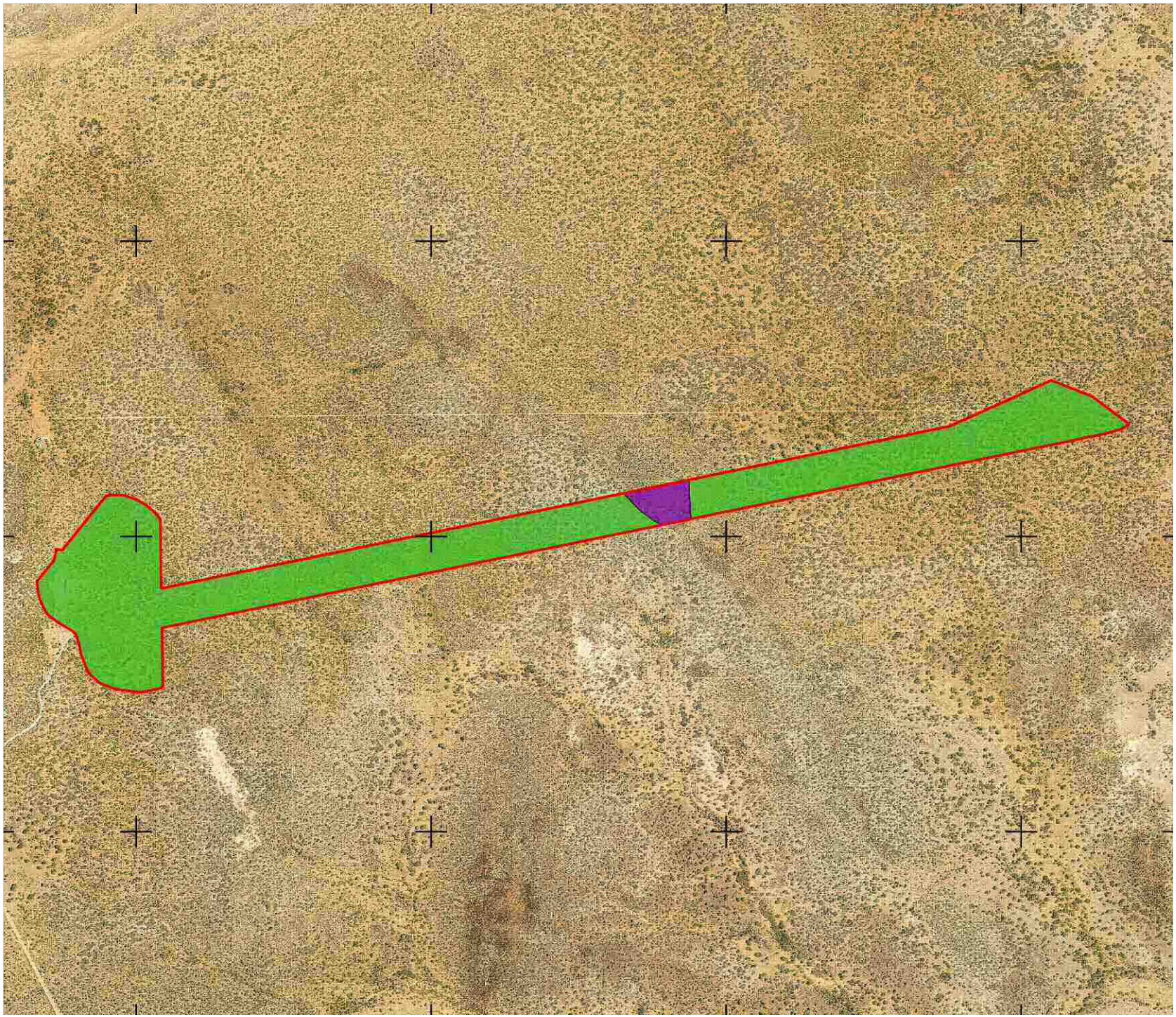
The Mixed Eucalypt Woodland was the most dominant habitat type throughout the Rayjax study area (Map 3.11). It covered 141.9 ha which represents 96.6% of the study area. The habitat type is characterised by a predominantly flat landscape. The vegetation comprised of a moderately open to dense woodland of *Eucalyptus salubris*, *E. clelandiorum* and *E. salmonophloia* over an open layer of mixed lower shrubs of *Eremophila scoparia*, *Senna artemisiodes*, *Atriplex* sp. and *Olearia muelleri*. The substrate consisted of brown sandy clay with leaf litter accumulated underneath trees and shrubs (Figure 3.6). Some pebbles (predominantly quartz) were present in some areas.

Figure 3.6: Mixed Eucalypt Woodland Habitat

3.3.2.2. Gentle Hillslope with Eucalypt Woodland

The Gentle Hillslope with Eucalypt Woodland was recorded from one location within the Rayjax Haul Road (Map 3.10). It covered 5.0 ha which represents 3.4% of the study area. a gentle hillslope dominated by a moderately open to dense woodland of *Eucalyptus moderata*, *E. oleosa* and *E. torquata* over an open layer of mixed lower shrubs of *Eremophila pustulata* E. *interstans*, *Acacia erinacea*, *Senna artimisioides*, *Atriplex vesicaria* and *Cratystylis conocephala*. (Figure 3.7). The substrate consisted of clay with some pebbles and plenty of leaf litter and moderate wood litter.

Figure 3.7: Gentle Hillslope with Eucalypt Woodland Habitat



Legend

Study Area

- Rajax Mine study area

Fauna Habitat Types

- Gentle Hillslope with Eucalypt Woodland
- Mixed Eucalypt Woodland

N

0.25 0 0.25 km

Scale 1:27000 @ A4

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: AH Approved: DC Date: 20-09-2019

Fauna Habitat Types Rayjax Study Area

Rayjax to Castle Hill

Map 3.11

Prepared for Evolution Mining

3.3.3. Burgundy to Cutters Ridge Haul Road

A total of four fauna habitat types were recorded from the Burgundy to Cutters Ridge Haul Road study area. Their extent is listed in Table 3.8 and shown in Map 3.12, and their details are described in the sections below.

Table 3.8: Fauna Habitat Types at Burgundy to Cutters Ridge Haul Road

Habitat Type	Extent (ha)	% of Study Area	Associated Vegetation Type
Gentle Hillslope with Eucalypt Woodland	46.4	13.1	Veg type iv
Mixed Eucalypt Woodland	292.7	82.6	Veg type iv
Minor Drainage Line	6.8	1.9	Veg type iv
Floodplain	8.2	2.3	Veg type vii

3.3.3.1. Gentle Hillslope with Eucalypt Woodland

The Gentle Hillslope with Eucalypt Woodland vegetation type was recorded from the northern section of the Burgundy to Cutters Ridge Haul Road study area (Map 3.12). It intersected the study area from the western areas where it formed considerable hills. This habitat covered 46.4 ha which represents 13.1% of the study area. It was characterised by Gentle Hillslopes which were dominated by moderately open Eucalypt trees, *Eucalyptus moderata*, *E. oleosa* and *E. torquate*), over a moderate layer of *Eremophila pustulata* E. *interstans*, *Acacia erinacea*, *Senna artimisioides*, *Atriplex vesicaria* and *Cratystylis conocephala* (Figure 3.8). The substrate consisted of sandy clay which was dominate by rocks and pebbles in patches.

Figure 3.8: Rocky Hillslope with Eucalypt Woodland Habitat

3.3.3.2. Mixed Eucalypt Woodland

The Mixed Eucalypt Woodland recorded from the Burgundy to Cutters Ridge Haul Road was dominated by tall eucalypt trees which formed denser patches in some sections. It covered 292.7 ha which represents 82.6% of the study area. The vegetation consisted of a moderately open to dense woodland of *Eucalyptus salubris*, *E. clelandiorum* and *E. salmonophloia* over mixed low shrubs of *Eremophila scoparia*, *Senna artemisiodes*, *Atriplex* sp. and *Olearia muelleri* (Figure 3.9). Leaf litter was plentiful and accumulated under the patches of trees, sometimes building a thick layer of dried up leaves in addition to some wood litter.

Figure 3.9: Mixed Eucalypt Woodland Habitat

3.3.3.3. Minor Drainage Line

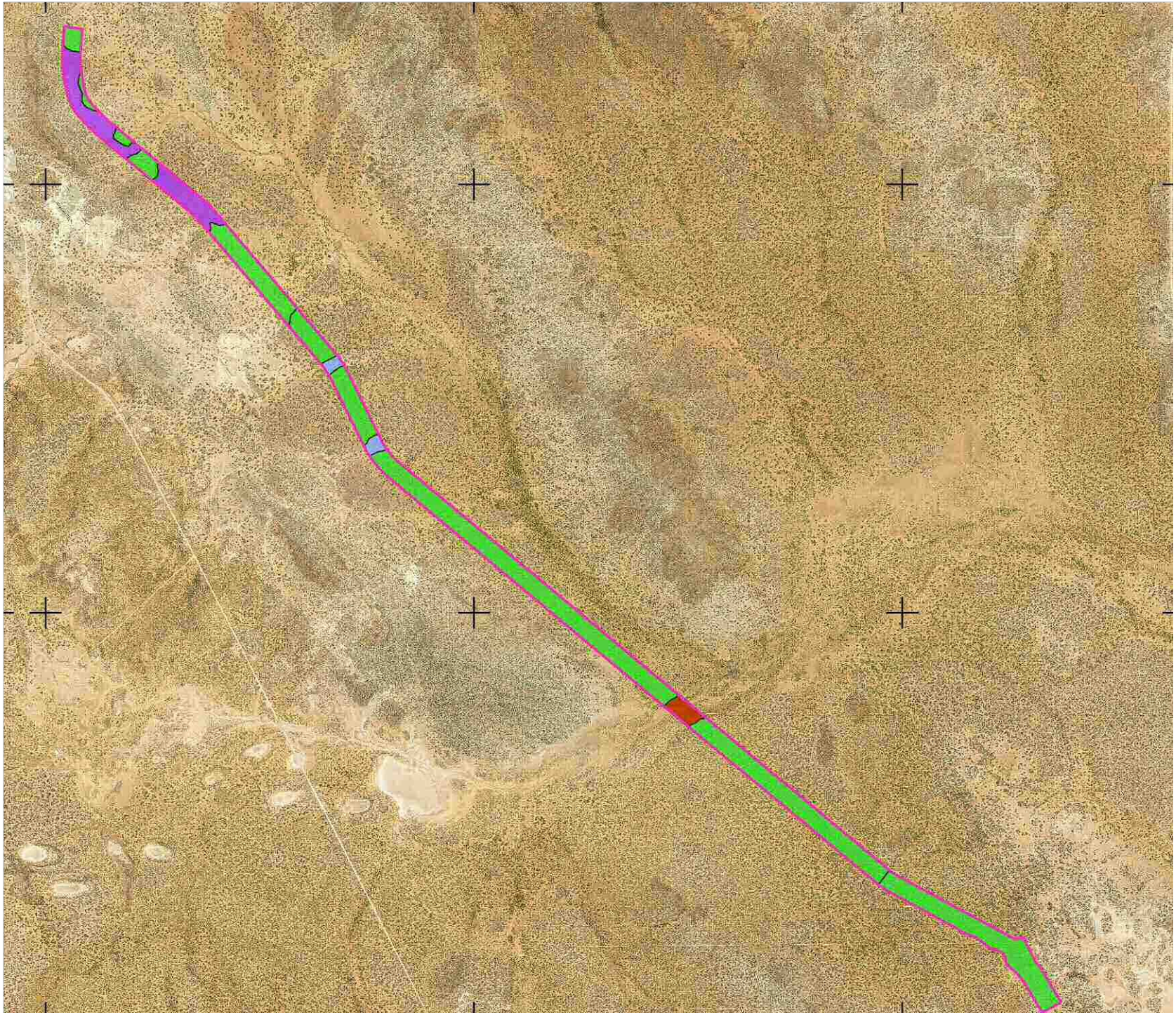
The Minor Drainage Line habitat was recorded from the centre of the Haul Road (Map 3.12). It covered 6.8 ha which represents 1.9% of the study area. It is dominated by a very open vegetation layer comprising of open eucalypt trees (*E. clelandiorum* and *E. salmonophloia)* over low open shrubs of *Eremophila scoparia, Senna artemisiodes*, *Atriplex* sp. and *Olearia muelleri* (Figure 3.10). Leaf litter was limited to trees along the fringe of the Drainage Line. The substrate consisted of heavy clay. Rocks and pebbles were generally lacking. This habitat is characterised by its areas of open or bare vegetation where water runs of after heavy rainfall events.

Figure 3.10: Minor Drainage Line Habitat

3.3.3.4. Floodplain

The floodplain was recorded at one location along the Burgundy to Cutters Ridge Haul Road (Map 3.12), covering 8.2 ha which represents 2.3% of the study area. The vegetation is dominated by scattered *Eucalyptus griffithsii* over an open tall shrubland of *Casuarina obesa* over a mixed lower shrublayer of *Senna artemisioides*, *Eremophila ionantha*, *Acacia hemiteles* and *Grevillea acuaria*, over patches of *Tecticornia halocnemoides* (Samphire) (Figure 3.11). The substrate comprises of firm clay with a thin layer of sand. Leaf litter accumulated under tall trees and shrubs but was otherwise sparse. Wood litter was sparse.

Figure 3.11: Floodplain Habitat



Legend

Study Area

- Burgundy to Cutters Ridge Haul Road

Fauna Habitat Types

- Gentle Hillslope with Eucalypt Woodland
- Minor Drainage Line
- Mixed Eucalypt Woodland
- Floodplain

N

0.5 0 0.5 km

Scale 1:62000 @ A4

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: AH Approved: DC Date: 20-09-2019

Fauna Habitat Types at Burgundy to Cutters Ridge Haul Road

Rayjax to Castle Hill

Map

Prepared for
Evolution Mining

3.12

3.3.4. TSF

A total of four fauna habitat types were recorded from the TSF area. An area of cleared vegetation (1.0 ha) is also present within the north-east area of the TSF Area; however, this does not represent a fauna habitat type as such and has been excluded from the below sections. The extent of each habitat type is listed in Table 3.9 and shown in Map 3.13, and their details are described in the sections below.

Table 3.9: Fauna Habitat Types at the TSF Area

Habitat Type	Extent (ha)	% of Study Area	Associated Vegetation Type
Eucalypt Woodland over Open Shrubland	380.4	89.7	Veg type iii, iv & v
Mixed Dense Shrubland	15.3	3.6	Veg type v
Saltbush Shrubland	28.4	6.7	Veg type ii
Claypan	0.8	0.2	Veg type xi
Cleared	1.0	0.2	-

3.3.4.1. Eucalypt Woodland over Open Shrubland

The Eucalypt Woodland over Open Shrubland was the most dominant habitat type throughout the TSF study area (Map 3.13). It covered 380.4 ha which represents 89.7% of the study area. The vegetation comprised of isolated trees of *Casuarina pauper* and *Melaleuca laterifora* with patches of Eucalypt trees (*Eucalyptus yilgarnensis*, *E. salubris* and *E. clelandiorum*) over an open layer of lower shrubs of *Eremophila scoparia*, *Senna artemisiodes*, *Frankenia setosa* and *Atriplex stipitata* and *Ptilotus obovatus*. The substrate consisted of brown sandy clay with plentiful leaf litter accumulated underneath trees and shrubs (Figure 3.12). Some pebbles (predominantly quartz) were present in some areas.

Figure 3.12: Eucalypt Woodland over Open Shrubland Habitat

3.3.4.2. Mixed Dense Shrubland

The Mixed Dense Shrubland was recorded from patches in the south and middle of the TSF study area (Map 3.13). It covers approximately 15.3 ha which represents 3.6% of the study area. The vegetation comprises of a dense layer of tall and mid shrubs of *Casuarina pauper*, *Melaleuca lateriflora*, *Frankenia setosa* and *Atriplex*

stipitata on sandy clay. Leaf litter is present under large shrubs and trees (Figure 3.13). The substrate was dominated by loamy clay with a slightly sandy cover. Some scattered small rocks or pebbles were only recorded in small patches.

Figure 3.13: Mixed Dense Shrubland Habitat

3.3.4.3. Saltbush Shrubland

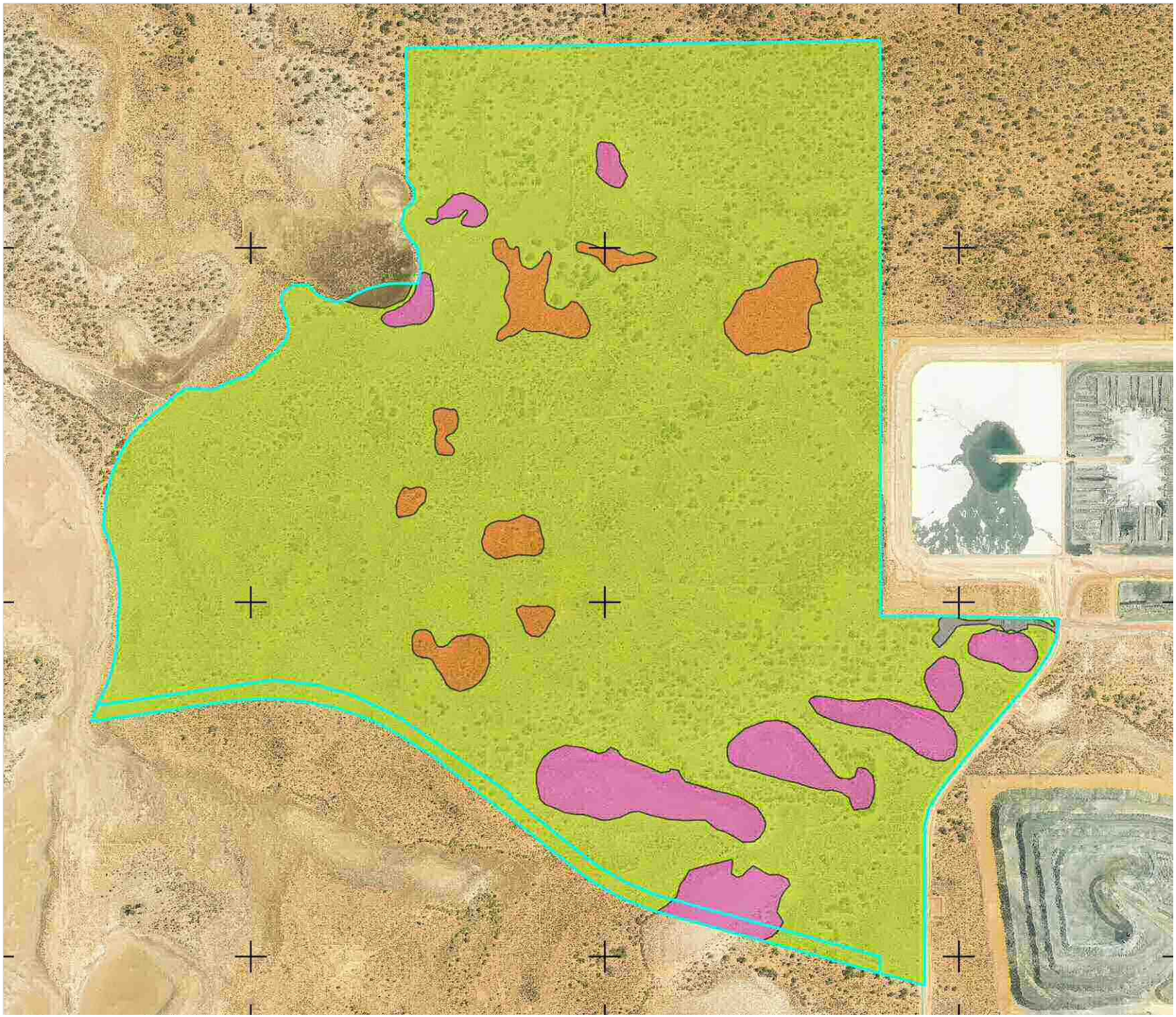
The Saltbush Shrubland habitat was recorded from the north-west and south-east section of the study area (Map 3.13). The Saltbush Shrubland habitat covered 28.4 ha which represents 6.6% of the TSF study area. It is dominated by Samphire shrubs (*Tecticornia halocnemoides*, *T. indica* and *T. chartacea*). The substrate was crusty loamy clay to sandy clay and leaf litter was very limited (Figure 3.14). Wood litter was absent from this habitat.

Figure 3.14: Saltbush Shrubland Habitat

3.3.4.4. Claypan

The Claypan habitat was recorded from the north-west corner of the TSF study area (Map 3.13). It covered 0.8 ha which represents 0.2% of the study area. It is characterised by a relatively uniform vegetation of *Duma florulenta* (Tangled Lignum) shrubs over grasses which were dried during the survey. Leaf litter and wood litter was generally absent (Figure 3.15). Due to the lack of trees and large shrubs, the substrate dries out quickly during the dry season and sun exposure would be high. During the time of the survey, the vegetation was predominantly dried out.

Figure 3.15: Claypan Habitat



Legend

Study Area

- TSF 3 & 4

Fauna Habitat Types

- Claypan
- Cleared
- Eucalypt Woodland over open Shrubland
- Mixed Dense Shrubland
- Saltbush Shrubland

N

0.2 0 0.2 km

Scale 1:15000 @ A4

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: AH Approved: DC Date: 20-09-2019

Fauna Habitat Types at TSF Area

Rayjax to Castle Hill

Map 3.13

Prepared for Evolution Mining

3.4. Vertebrate Fauna

3.4.1. Castle Hill

A total of 11 vertebrate fauna species were recorded during the survey: one native mammal species, one introduced mammal species, and nine bird species (Table 3.10), all of which are widespread species. No species of conservation significance were recorded during the survey (Table 3.10). The introduced Rabbit is widespread in the area and secondary evidence in the form of scats and diggings has been sighted throughout the Castle Hill study area study area. The most commonly recorded bird species was the Purple-crowned Lorikeet which is likely to breed in hollow logs and eucalypt branches.

Table 3.10: Vertebrate Fauna Species Recorded - Castle Hill

Common Name	Scientific Name	Conservation Status	Comments/Details
Mammals			
Western Grey Kangaroo	*Macropus fuliginosus*	-	Scats & tracks
*Rabbit	*Oryctolagus cuniculus*	-	Scats & diggings
Birds			
Purple-crowned Lorikeet	*Parvipsitta porphyrocephala*	-	12 individuals
Striated Pardalote	*Pardalotus striatus*	-	3 individuals
Australian Ringneck	*Platycercus zonarius*	-	4 individuals
Galah	*Cactua roseicapilla*	-	4 individuals
Crested Bellbird	*Oreoica gutturalis*	-	2 individuals
Yellow-plumed Honeyeater	*Ptilotula ornata*	-	1 individual
Weebill	*Smicromis brevirostris*	-	10 individuals
Red Wattlebird	*Anthochaera carunculata*	-	2 individuals
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	-	1 individual

*Introduced Species

3.4.2. Rayjax

A total of eight vertebrate fauna species were recorded during the survey: one native mammal species, two introduced mammal species, four bird species, and one reptile (Table 3.10), all of which are widespread species. No species of conservation significance were recorded during the survey (Table 3.10). The Rabbit was recorded across the majority of the study area and surrounding area. The dog was recorded through secondary evidence only (scats). The most commonly recorded bird species was the Purple-crowned Lorikeet which was also recorded from the other study areas. One reptile species was recorded from within the Rayjax study area study area; the Bobtail (*Tiliqua rugosa*). The species is a common reptile across Western Australia (Table 3.10).

Table 3.11: Vertebrate Fauna Species Recorded - Rayjax

Common Name	Scientific Name	Conservation Status	Comments/Details
Mammals			
Western Grey Kangaroo	*Macropus fuliginosus*	-	Scats & tracks
*Rabbit	*Oryctolagus cuniculus*	-	Scats & diggings

Common Name	Scientific Name	Conservation Status	Comments/Details
*Dog	*Canis familiaris*	-	Scats
Birds			
Varied Sittella	*Daphoenositta chrysoptera*	-	3 individuals
Purple-crowned Lorikeet	*Parvipsitta porphyrocephala*	-	10 individuals
Willie Wagtail	*Rhipidura leucophrys*	-	1 individual
Yellow-plumed Honeyeater	*Ptilotula ornata*	-	4 individuals
Reptiles			
Bobtail	*Tiliqua rugosa*	-	remains

*Introduced Species

3.4.3. Burgundy to Cutters Ridge Haul Road

A total of 15 vertebrate fauna species were recorded during the survey: one native mammal species, three introduced mammal species, eight bird species and three reptiles (Table 3.10), all of which are widespread species. No species of conservation significance were recorded during the survey (Table 3.10). The three introduced species, Rabbit, Dog and Cattle, which were recorded through secondary evidence are widespread and commonly recorded in the area.

Table 3.12: Vertebrate Fauna Species Recorded – Burgundy to Cutters Ridge

Common Name	Scientific Name	Conservation Status	Comments/Details
Mammals			
Western Grey Kangaroo	*Macropus fuliginosus*	-	Scats
*Rabbit	*Oryctolagus cuniculus*	-	Scats
*Dog	*Canis familiaris*	-	Scats
*Cattle	*Bos taurus*	-	Scats and tracks
Birds			
Red Wattlebird	*Anthochaera carunculata*	-	2 individuals
Rufous Whistler	*Pachycephala rufiventris*	-	1 individual
Weebill	*Smicromis brevirostris*	-	3 individuals
Striated Pardalote	*Pardalotus striatus*	-	6 individuals
Purple-crowned Lorikeet	*Parvipsitta porphyrocephala*	-	4 individuals
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	-	1 individual
Yellow-plumed Honeyeater	*Ptilotula ornata*	-	1 individual
Chestnut Quail-thrush	*Cinclosoma castanotum*	-	1 individual
Reptiles			
Barking Gecko	*Underwoodisaurus milii*	-	1 individual
A skink	*Hemiergis initialis*	-	1 individual
A gecko	*Heteronotia binoei*	-	1 individual

*Introduced Species

3.4.4. TSF

A total of 13 vertebrate fauna species were recorded during the survey: one native mammal species, three introduced mammal species, and nine bird species (Table 3.10), all of which are widespread species. No Conservation Significant fauna species were recorded during the survey (Table 3.10). The three introduced species, Rabbit, Dog and Cattle, are commonly recorded in the area. All three species were recorded through secondary evidence. The Emu (2 individuals) was repeatedly recorded from the main access track in the southern section of the TSF Area. An inactive nest was recorded from outside the study area, and the frequent sightings of the adult individuals indicates that the species is a resident which breeds in the area.

Table 3.13: Vertebrate Fauna Species Recorded – TSF Area

Common Name	Scientific Name	Conservation Status	Comments/Details
Mammals			
Western Grey Kangaroo	*Macropus fuliginosus*	-	2 individuals & scats
*Rabbit	*Oryctolagus cuniculus*	-	Scats and diggings
*Dog	*Canis familiaris*	-	Scats
*Cattle	*Bos taurus*	-	Scats and tracks
Birds			
Emu	*Dromaius novaehollandiae*	-	2 individuals
Crested Bellbird	*Oreoica gutturalis*	-	2 individuals
Weebill	*Smicromis brevirostris*	-	3 individuals
Black-faced Woodswallow	*Artamus cinereus*	-	1 individual
White-winged Fairy-wren	*Malurus leucopterus*	-	Heard
Red Wattlebird	*Anthochaera carunculata*	-	3 individuals
White-eared Honeyeater	*Lichenostomus leucotis*	-	1 individual
White-fronted Honeyeater	*Purnella albifrons*	-	1 individual
Brown Falcon	*Falco berigora*	-	1 individual

*Introduced Species

3.5. Invertebrate SRE Fauna

3.5.1. Castle Hill

During the survey, 13 potential SRE invertebrate fauna taxa were collected from the Castle Hill study area. They consisted of six pseudoscorpions, two isopods, one centipede, three millipedes and one snail (Table 3.14). One of the five pseudoscorpions (*Chernetidae* sp.) and one of the three millipedes (*Unixenus* sp.) could not be identified to species level because the specimens were juveniles, and adult specimens are required for formal identification to species level. It could potentially belong to *Chernetidae* `BPS211` which was recorded from the Rayjax mine (Figure 3.16, Table 3.15).

Two individuals of the snail, *Basedowena* cf. *holoserica* were collected from the Castle Hill Mine and could potentially represent a new species, although resembling *Basedowena holoserica* (Figure 3.16).

Three of the recorded 13 taxa are shown on Figure 3.16: *Beierolpium* 8/4 sp. (C), *Buddelundia* `BIS352` (A), and *Basedowena* cf. *holoserica* (B).

Table 3.14: Recorded SRE Invertebrates – Castle Hill

Order/Family	Taxa	Location	Sampling Type (# of Sites)	Abundance	SRE Category
Pseudoscorpiones					
Garypinidae	*Amblyoplium* `BPS207`	Castle Hill Mine	Leaflitter (1)	1	Potential SRE
Cheiridiidae	*Apocheriridium* `BPS208`	Castle Hill Mine	Leaflitter (2)	4	Potential SRE
Olpiidae	*Beierolpium* 8/4 sp.	Castle Hill Mine	Leaflitter (1)	1	Potential SRE
Chernetidae	*Chernetidae* sp.	Castle Hill Mine	Leaflitter (3)	3	Potential SRE
Geogarypidae	*Geogarypus taylori*	Castle Hill Mine	Leaflitter (1)	1	Potential SRE
Cheliferidae	*Protochelifer* `BPS210`	Castle Hill Mine	Leaflitter (3)	3	Potential SRE
Isopoda					
Armadillidae	*Buddelundia* `BIS350`	Castle Hill & Castle Hill Haul Road	Foraging, Leaflitter (2)	3	Potential SRE
	Buddelundia `BIS352`	Castle Hill Mine	Leaflitter (1)	1	Potential SRE
Chilopoda					
Cryptopidae	*Cryptops* nr *hortensis*	Castle Hill Mine		1	Potential SRE
Diplopoda					
Polyxenidae	*Unixenus* sp.	Castle Hill Mine	Leaflitter (2)	2	Potential SRE
Scutigerellidae	*Hanseniella* `BSYM093`	Castle Hill Mine	Leaflitter (1)	1	Potential SRE
Siphonotidae	*Siphonotidae* `BDI064`	Castle Hill Mine	Leaflitter (4)	5	Potential SRE
Mollusc					
Camaenidae	*Basedowena* cf. *holoserica*	Castle Hill Mine	Foraging, Leaflitter (1)	2	Potential SRE

3.5.2. Rayjax

During the survey, nine potential SRE invertebrate fauna taxa were collected from the Rayjax study area. They consisted of four pseudoscorpions, one isopod, one centipede, three millipedes and one snail (Table 3.15). One of the pseudoscorpions (*Chernetidae* sp.) and one of the millipedes (*Antichiropus* sp., Figure 3.16) could not be identified to species level because the specimens were juveniles, and adult specimens are required for formal identification to species level. The pseudoscorpion could potentially belong to *Chernetidae* `BPS211` which was also recorded from the Rayjax study area (Figure 3.16).

One individual of the snail, *Basedowena* cf. *holoserica* was collected from the Rayjax Mine and could potentially represent a new species, although resembling *Basedowena holoserica* (Figure 3.16).

Six of the recorded nine taxa are shown on Figure 3.16: *Apocheriridium* `BPS209` (F), Chernetidae `BPS211` (H), *Acanthodillo* `BIS353` (G), *Antichiropus* sp. (E), *Phryssonotus novaehollandiae* (I) and *Basedowena* cf. *holoserica* (B).

Table 3.15: Recorded SRE Invertebrates – Rayjax

Order/Family	Taxa	Location	Sampling Type (# of Sites)	Abundance	SRE Category
Pseudoscorpiones					
Cheiridiidae	*Apocheriridium* `BPS208`	Rayjax	Leaflitter (1)	1	Potential SRE
	Apocheriridium `BPS209`	Rayjax	Leaflitter (2)	2	Potential SRE
Chernetidae	Chernetidae sp.	Rayjax	Leaflitter (1)	1	Potential SRE
	Chernetidae `BPS211`	Rayjax	Leaflitter (1)	1	Potential SRE
Isopoda					
Armadillidae	*Acanthodillo* `BIS353`	Rayjax	Leaflitter (1)	1	Potential SRE
Diplopoda					
Paradoxosomatidae	*Antichiropus* sp.	Rayjax	Foraging	1	Potential SRE
Synxenidae	*Phryssonotus novaehollandiae*	Rayjax	Leaflitter (1)	1	Potential SRE
Mollusc					
Camaenidae	*Basedowena* cf. *holoserica*	Rayjax & Rayjax Haul Road	Leaflitter (2)	1	Potential SRE
Pupillidae	*Gastrocopta bannertonensis*	Rayjax	Leaflitter (1)	1	Potential SRE

3.5.3. Burgundy to Cutters Ridge Haul Road

During the survey, 11 potential SRE invertebrate fauna taxa were collected from the Burgundy to Cutters Ridge Haul Road. They consisted of three pseudoscorpions, two isopods, one millipede and five snail (Table 3.16). One of the pseudoscorpions (*Chernetidae* sp.) could not be identified to species level because the specimen was a juvenile, and adult specimens are required for formal identification to species level. The pseudoscorpion could potentially belong to *Nesidiochernes* `BPS212` or Chernetidae `BPS211` which were recorded from the study area and Rayjax mine.

Two individuals of the snail, *Basedowena* cf. *holoserica* was collected from the Burgundy to Cutters Risge Haul Road and could potentially represent a new species, although resembling *Basedowena holoserica* (Figure 3.16).

Three of the recorded 11 taxa are shown on Figure 3.16: *Acanthodillo* `BIS353`(G), *Basedowena* cf. *holoserica* (B) and *Phryssonotus novaehollandiae* (I).

Table 3.16: Recorded SRE Invertebrates – Burgundy to Cutters Ridge Haul Road

Order/Family	Taxa	Location	Sampling Type (# of Sites)	Abundance	SRE Category
Pseudoscorpiones					
Cheiridiidae	*Apocheriridium* `BPS208`	Haul Road	Leaflitter (2)	6	Potential SRE
Chernetidae	Chernetidae sp.	Haul Road	Leaflitter (3)	3	Potential SRE
	Nesidiochernes `BPS212`	Haul Road	Leaflitter (1)	2	Potential SRE

Order/Family	Taxa	Location	Sampling Type (# of Sites)	Abundance	SRE Category
Isopoda					
Armadillidae	*Acanthodillo* `BIS353`	Haul Road	Leaflitter (1)	2	Potential SRE
	Acanthodillo `BIS350`	Haul Road	Foraging, Leaflitter (1)	4	Potential SRE
Polyxenida					
Synxenidae	*Phryssonotus novaehollandiae*	Haul Road	Leaflitter (2)	2	Potential SRE
Mollusc					
Camaenidae	*Basedowena* cf. *holoserica*	Haul Road	Foraging, Leaflitter (1)	2	Potential SRE
Pupillidae	*Gastrocopta bannertonensis*	Haul Road	Leaflitter (1)	1	Potential SRE
	Pupoides adelaidae	Haul Road	Leaflitter (1)	1	Potential SRE
Punctidae	*Westralaoma expicta*	Haul Road	Leaflitter (1)	2	Potential SRE
Succineidae	*Succinae* sp.	Haul Road	Leaflitter (1)	1	Potential SRE

3.5.4. TSF Study Area

During the survey, five potential SRE invertebrate fauna taxa were collected from the TSF Area. They consisted of one pseudoscorpion, one isopod, one geophilomorph and two snail (Table 3.17). One of the pseudoscorpions (*Chernetidae* sp.) could not be identified to species level because the specimen was a juvenile, and adult specimens are required for formal identification to species level. It could potentially belong to the taxa Chernetidae `BPS211` which was recorded from the Rayjax mine (Figure 3.16, Table 3.15)

One individual of the snail, *Basedowena* cf. *holoserica* was collected from the TSF Area and could potentially represent a new species, although resembling *Basedowena holoserica* (Figure 3.16).

The recorded geophilomorph *Sepedonophilus* `BGE043` (D) is shown for reference on Figure 3.16.

Table 3.17: Recorded SRE Invertebrates

Order/Family	Taxa	Location	Sampling Type (# of Sites)	Abundance	SRE Category
Pseudoscorpiones					
Chernetidae	Chernetidae sp.	TSF	Leaflitter (1)	1	Potential SRE
Isopoda					
Armadillidae	*Buddelundia* `BIS350`	TSF	Foraging, Leaflitter (1)	2	Potential SRE
Geophilida					
Chilenophilidae	*Sepedonophilus* `BGE043`	TSF	Foraging	1	Potential SRE
Mollusc					
Camaenidae	*Basedowena* cf. *holoserica*	TSF	Foraging	1	Potential SRE
	Sinumelon kalgum	TSF	Foraging	1	Potential SRE

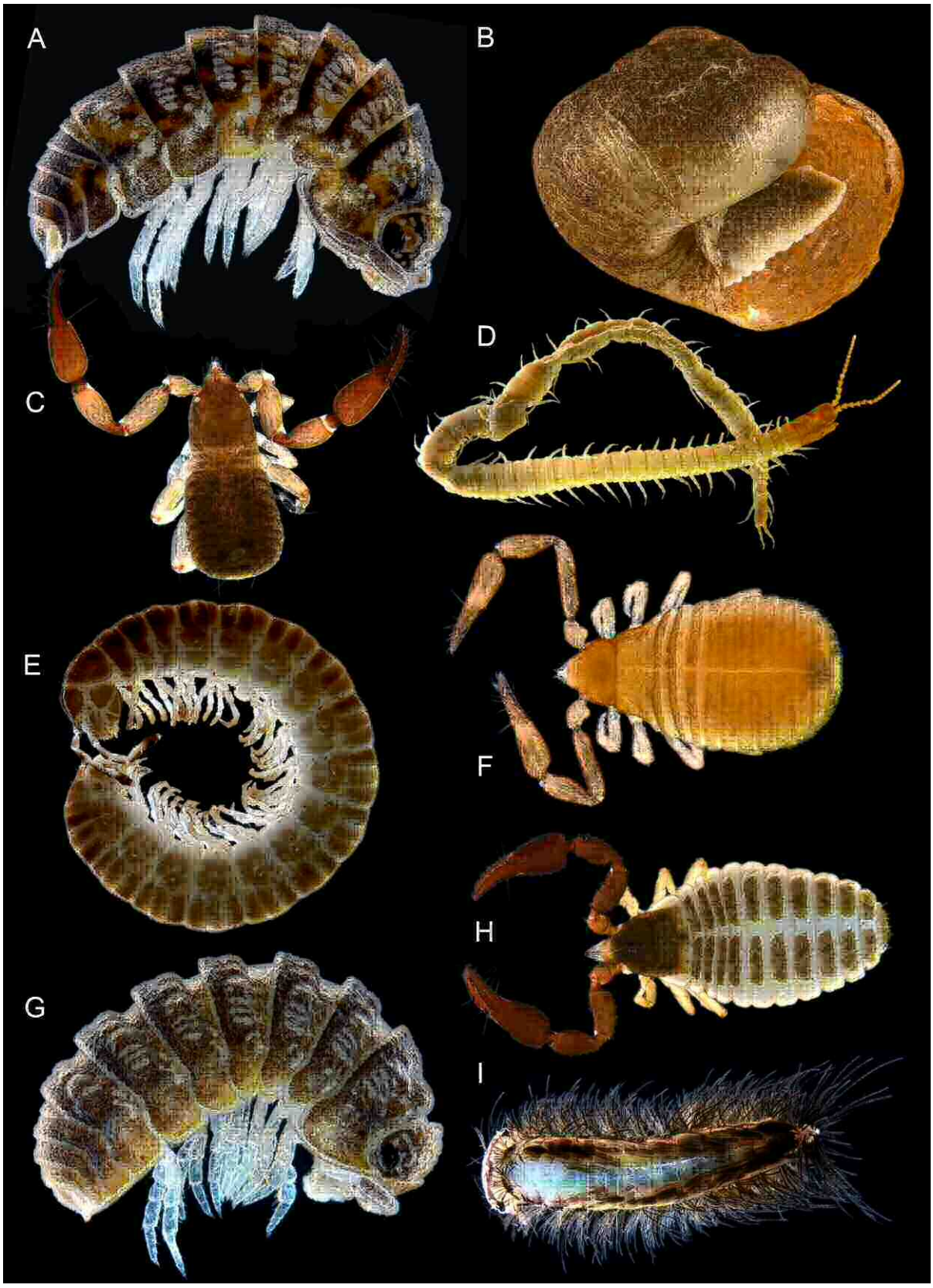
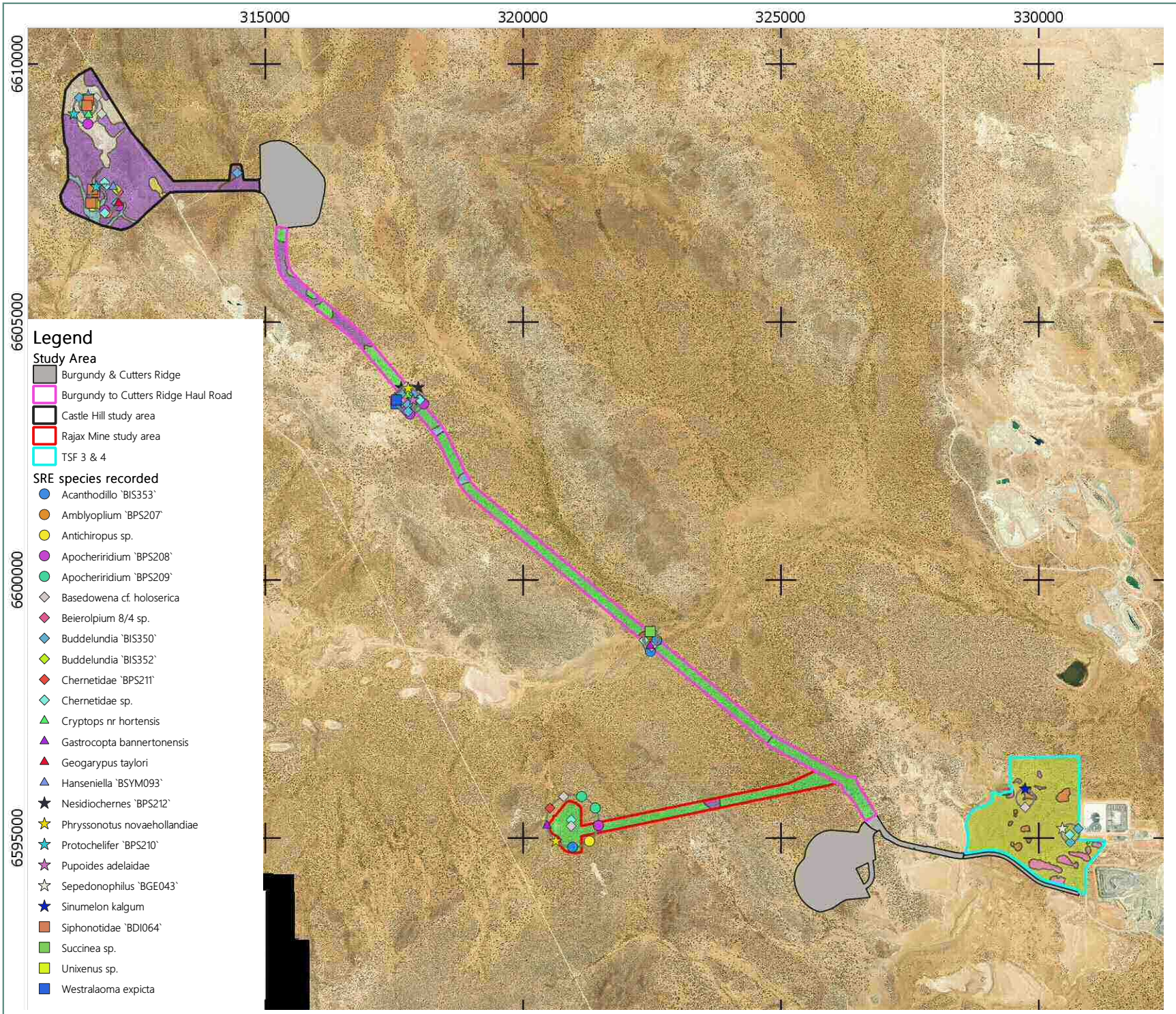


Figure 3.16: Selection of SRE Invertebrate Fauna Species Recorded from the Study Areas

A-Buddelundia `BIS352`; B-Basedowena cf. holoserica; C-Beierolpium 8/4sp.; D-Sepedonophilus `BGE043`; E-Anichiropus sp. F-Apocheridium `BSP209`; G-Acanthodillo `BIS353`; H-Chernetidae `BPS211`; I-Phryssonotus novaehollandiae



N

1 0 1 2 km

Scale 1:100000 @ A4

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Units: Meter

Spectrum ECOLOGY

Author: AH Approved: DC Date: 20-09-2019

SRE Species recored during the survey

Rayjax to Castle Hill

Map

Prepared for
Evolution Mining

3.14

4. DISCUSSION

4.1. Flora

4.1.1. Threatened Flora

Two threatened flora taxa were recorded during the database searches: *Conostylis lepidospermoides* (EPBC Act: Endangered, BC Act: Vulnerable) and *Gastrolobium graniticum* (EPBC Act: Endangered, BC Act: Vulnerable). They were both assigned a Medium likelihood of occurrence as they occur within 14 km and 19 km, respectively, and suitable habitat may occur within the study areas which is discussed below for each species.

Conostylis lepidospermoides is known to occur on flat or gently undulating plains in yellow or grey sand over laterite clay, in low heath and sedge communities with other scattered emergent species. The previous record in the region falls on one geological unit (Czc) which is also located within the Castle Hill study area, Rayjax study area and Burgundy to Cutters Ridge Haul Road study area, and therefore potential habitat could occur within these areas.

Gastrolobium graniticum is known to occur on the margins of granite outcrops, especially along drainage lines, on sandy soils in open woodland in association with *Allocasuarina huegeliana*. Previous records fall on five geological units (Qa, Czc, Czl, Agb and As) which also occur within the Castle Hill study area (Czl & Czc), the Rayjax study area (Czc), and the Burgundy to Cutters Ridge Haul Road study area (Czc, QA, As and Czl), and therefore potential habitat could occur within these areas.

4.1.2. Local and Regional Significance

Potential impacts to significant flora recorded at the study areas during the survey and in the desktop assessment are considered at a local and regional scale. Significant flora recorded in the vicinity of the study areas during the database searches, and assigned a high likelihood of occurrence, are also presented in Table 4.1.

Priority flora that are considered to have high significance at a local scale, if impacted at the study area include: *Calandrinia lefroyensis/quartzitica* (Priority 1), and *Calandrinia* sp. Gypsum (F. Obbens & L. Hancock FO 10/14) (SOI) (both recorded during the database searches). An additional three species are considered to have low significance at a local scale: *Eremophila praecox* (P1), *Allocasuarina eriochlamys* sp. *grossa* (P3), and *Eucalyptus jutsonii* subsp. *jutsonii* (P4).

Priority flora that are considered to have high significance at a regional scale, if impacted at the study area include: *Calandrinia lefroyensis/quartzitica* (Priority 1; recorded during the database searches). The remaining five species listed in Table 4.1 have low significance at a regional scale.

Table 4.1: Local and Regional Significance of the Flora of the Study Area

Status & Record	Taxa	Local Significance at the Study Area	Regional Significance at the Study Area	Study Areas
Priority 1				
Desktop	*Calandrinia lefroyensis/ quartzitica*	Uncommon in the local area, only two locations recorded previously – high local significance.	Only known from a small area south of the study area with a range of less than 100 km (*C. lefroyensis*) and common in the Murchison but not recorded in the Coolgardie region before (*C. quartzitica)*, – high regional significance.	Castle Hill: No habitat present Rayjax: No habitat present Haul Road: No habitat present TSF: Previously recorded closeby and habitat present (veg ii)
	Eremophila praecox	Common in the local area, 18 locations within 40 km with one record 350 m east of the Burgundy to Cutters Ridge Haul Road – low local significance.	Known from two areas in the Coolgardie region over a 200 km range – low regional significance.	Castle Hill: Habitat present (veg iv) Rayjax: Habitat present (veg iv) Haul Road: Habitat present/recorded closeby (veg iv) TSF: Habitat present (veg iv)
Priority 3				
Current Survey	*Allocasuarina eriochlamys* subsp. *grossa*	Common in the local area, three locations with numerous records surrounding the study area – low local significance.	Known from many records spanning over 500 km across the Coolgardie and Nullarbor regions – low regional significance.	Castle Hill: No habitat present Rayjax: No habitat present Haul Road: Recorded 450 m west of study area during current survey, no habitat present TSF: No habitat present
Desktop	*Austrostipa blackii*	Uncommon in the local area with two known locations surrounding the study areas – low local significance.	Known from many records spanning over 700 km throughout the Coolgardie, Nullarbor and Yalgoo IBRA regions – low regional significance.	Castle Hill: No habitat present Rayjax: Habitat present (veg vi) Haul Road: No habitat present TSF: No habitat present
Priority 4				
Desktop	*Eucalyptus jutsonii* subsp. *jutsonii*	Common in the local area with known locations surrounding the study areas – low local significance.	Known from many records spanning over 300 km across the Coolgardie and Murchison regions – low regional significance.	Castle Hill: No habitat present Rayjax: No habitat present Haul Road: Habitat present (veg vii) TSF: No habitat present
Species of Interest				

Status & Record	Taxa	Local Significance at the Study Area	Regional Significance at the Study Area	Study Areas
Desktop	*Calandrinia* sp. Gypsum (F. Obbens & L. Hancock FO 10/14)	One known location recorded from the local area and a northerly range extension for the species – high local significance.	Known from many records spanning over 1000 km across the Wheatbelt, Coolgardie, Esperance Plains and Mallee regions – low regional significance.	Castle Hill: No habitat present Rayjax: No habitat present Haul Road: Habitat present (veg vii) TSF: No habitat present

4.2. Vegetation

4.2.1. Vegetation Resembling TEC or PECs

None of the vegetation units recorded resemble the Emu land system PEC, or other known TEC or PECs from the Coolgardie region.

4.2.2. Local and Regional Significance

The local significance of the eight vegetation units considered significant are described in Table 4.2.

Table 4.2: Significant Vegetation Recorded at the Study Areas

Unit	Description	Reason	Study Areas	Locally Significant
ii	*Tecticornia halocnemoides* ssp. *halocnemoides*, *T. indica* ssp. *indica* and *T. chartacea* low open chenopod shrubland	Role as refugee for P1 *Calandrinia lefroyensis/C. quartzitica* and complex *Tecticornia* species	TSF	High – Provides habitat for flora with a high local significance.
iii	*Eucalyptus yilgarnensis*, *E. salubris* and *E. clelandiorum* mid woodland over *Eremophila scoparia*, *Senna artemisiodes* ssp. *filifolia* mid open shrubland over *Ptilotus obovatus* low isolated shrubs	Restricted	TSF	Low – likely to be widespread throughout local area based on Beard
iv	*Eucalyptus salubris*, *E. clelandiorum* (+/-*E. salmonophloia*) mid open woodland over *Eremophila scoparia* and *Senna artemisiodes* ssp. *filifolia* mid open shrubland over *Atriplex* sp. and *Olearia muelleri* low open shrubland	Role as refugee for P1	Castle Hill, Rayjax, Haul Road and TSF	Low – widespread throughout local area
v	*Casuarina pauper* low isolated trees over *Melaleuca lateriflora* mid open shrubland over *Frankenia setosa* and *Atriplex stipitata* low open shrubland	Role as refugee for P1 *Calandrinia lefroyensis/C. quartzitica*	TSF	High – uncommon in local area and provides habitat for flora with a high local significance
vi	*Eucalyptus moderata*, *Eucalyptus oleosa* and *E. torquata* tall mallee woodland over *Eremophila pustulata* and *Eremophila interstans* ssp. *interstans* tall sparse shrubland over *Acacia erinacea*, *Senna artimisioides* ssp. f*ilifolia*, and *Atriplex vesicaria* low sparse shrubland	Restricted	Rayjax	Low – likely to be widespread throughout local area based on Beard
vii	*Eucalyptus griffithsii* low woodland over *Senna artemisioides* and *Eremophila ionantha* mid sparse shrubland over *Acacia hemiteles* and *Grevillea acuaria* low sparse shrubland	Restricted	Haul Road	High – possibly restricted in the local area based on Beard
viii	*Eucalyptus griffithsii* low woodland over *Eremophila scoparia*, *E. interstans* ssp. *virgata* and *Acacia hemiteles* mid to tall open shrubland	Restricted	Castle HIll	Low – likely to be widespread throughout local area based on Beard
xi	*Duma florulenta* mid sparse shrubland	Restricted	TSF	Low – likely to be widespread throughout local area based on Beard

The best available regional vegetation dataset available to assess the regional distribution and significance of the vegetation of the study area is the pre-European vegetation mapping originally undertaken by Beard (Department of Primary Industry and Regional Development, 2019). To assess if any of the vegetation types recorded in the study area are regionally significant, they have been aligned with the pre-European vegetation units as listed in Table 4.3 . The majority of the vegetation types loosely align with a pre-European unit, which indicates that these vegetation types are more widespread throughout the region as they are associated with these larger units.

One vegetation type (vii) geographically aligns with pre-European vegetation unit 221, however the species are not similar. This unit is restricted within the Coolgardie region (11,764 ha) and it is therefore possible that vegetation type vii is also restricted in the region and is therefore considered potentially regionally significant.

Table 4.3: Vegetation Types Mapped at the Study Area and Pre-European Vegetation Units

Unit	NVIS Level IV Vegetation Association	Area in Study Areas (ha)	Current Extent Coolgardie (ha)	Vegetation Types at the Study Area
9	*Eucalyptus torquata, E. lesouefii, E. clelandiorum* (syn: *clelandii*) low woodland over *Eremophila scoparia, E. glabra, E. oldfieldii* tall sparse heathland and sparse chenopod shrubland over isolated ground species	211.4	235,101	iv: *Eucalyptus salubris*, *E. clelandiorum* (+/-*E. salmonophloia*) mid open woodland over *Eremophila scoparia* and *Senna artemisiodes* ssp. *filifolia* mid open shrubland over *Atriplex* sp. and *Olearia muelleri* low open shrubland vi: *Eucalyptus moderata*, *Eucalyptus oleosa* and *E. torquata* tall mallee woodland over *Eremophila pustulata* and *Eremophila interstans* ssp. *interstans* tall sparse shrubland over *Acacia erinacea*, *Senna artimisioides* ssp. *filifolia*, and *Atriplex vesicaria* low sparse shrubland
221	Isolated trees and isolated shrubs over *Atriplex* sp. low open shrubland and open chenopod shrubland	10	11,764	vii: *Eucalyptus griffithsii* low woodland over *Senna artemisioides* and *Eremophila ionantha* mid sparse shrubland over *Acacia hemiteles* and *Grevillea acuaria* low sparse shrubland
468	*Eucalyptus salmonophloia, E. dundasii* mid woodland over isolated shrubs and isolated ground species	639.9	430,756	i: *Eucalyptus campaspe* and *E. salmonophloia* mid open woodland over *Atriplex nummularia* ssp. *spathulata* and *Eremophila interstans* ssp. *interstans* mid sparse shrubland over *Atriplex vesicaria* low sparse shrubland ix: *Eucalyptus clelandiorum* tall mallee woodland over *Eremophila scoparia*, *Acacia burkittii* and *Atriplex nummularia* ssp. *spathulata* low sparse shrubland x: *Eucalyptus griffithsii* low isolated trees over *Acacia burkittii*, *Eremophila scoparia* and *Atriplex nummularia* ssp. *spathulata* mid to tall open shrubland viii: *Eucalyptus griffithsii* low woodland over *Eremophila scoparia*, *E. interstans* ssp. *virgata* and *Acacia hemiteles* mid to tall open shrubland iv: *Eucalyptus salubris*, *E. clelandiorum* (+/-*E. salmonophloia*) mid open woodland over *Eremophila scoparia* and *Senna artemisiodes* ssp. *filifolia* mid open shrubland over *Atriplex* sp. and *Olearia muelleri* low open shrubland
468.1 - mosaic	*Eucalyptus lesouefii, E. salmonophloia, E. transcontentalis* tall woodland, over *Eremophila scoparia, E. alternifolia, E. decipiens* tall open shrubland	120.9	61,727	iv: *Eucalyptus salubris*, *E. clelandiorum* (+/-*E. salmonophloia*) mid open woodland over *Eremophila scoparia* and *Senna artemisiodes* ssp. *filifolia* mid open shrubland over *Atriplex* sp. and *Olearia muelleri* low open shrubland
520	Isolated trees over *Acacia quadrimarginea* tall shrubland over isolated ground species	33.0	30,194	-

Unit	NVIS Level IV Vegetation Association	Area in Study Areas (ha)	Current Extent Coolgardie (ha)	Vegetation Types at the Study Area
540.1	*Casuarina cristata* subsp *cristata, Myoporum platycarpum, Callitris columellaris* low open woodland over *Eremophila miniata, Grevillea sarissa* tall sparse shrubland over *Atriplex hymenotheca* low open shrubland and low open chenopod shrubland	363.1	48,376	v: *Casuarina pauper* low isolated trees over *Melaleuca laterifora* mid open shrubland over *Frankenia setosa* and *Atriplex stipitata* low open shrubland iv: *Eucalyptus salubris*, *E. clelandiorum* (+/-*E. salmonophloia*) mid open woodland over *Eremophila scoparia* and *Senna artemisiodes* ssp. *filifolia* mid open shrubland over *Atriplex* sp. and *Olearia muelleri* low open shrubland ii: *Tecticornia halocnemoides* ssp. *halocnemoides*, *T. indica* ssp. *indica* and *T. chartacea* low open chenopod shrubland iii: *Eucalyptus yilgarnensis*, *E. salubris* and *E. clelandiorum* mid woodland over *Eremophila scoparia, Senna artemisiodes* ssp. *filifolia* mid open shrubland over *Ptilotus obovatus* low isolated shrubs xi: *Duma florulenta* mid sparse shrubland

4.3. Fauna

4.3.1. Fauna Habitats

All habitat types recorded from the survey are commonly recorded in the region and are not restricted to the study areas. In particular the Mixed Eucalypt Woodland and Open Eucalypt Woodland over Open Shrubland habitat types are widespread and have been recorded from other fauna assessments in the wider region (McKenzie *et al.*, 1984; Ecologia 2013; Harewood, 2014a; Botanica Consulting, 2018; Spectrum 2018; Phoenix 2019).

The Gentle Hillslope with Eucalypt Woodland habitat was often associated with smaller hills that extended into adjacent areas and were only marginally covered by the study areas. They have also been recorded from the wider region during previous assessment (Terrestrial Ecosystem, 2016; GHD, 2018; Spectrum Ecology, 2018).

The Mixed Dense Shrubland was recorded from a few smaller patches within the Eucalypt Woodland habitat types. They are common in the area, but are also particularly suitable for the Malleefowl if long unburnt (Benshemesh, 1990). The Mixed Dense Shrubland habitat type is not uncommon as such and has been found during a number of previous surveys in the region (Ecologia 2013; GHD, 2018; Spectrum 2018).

The Minor Drainage Line habitat often intersect surrounding habitat types in a linear manner. Due to the ability to maintain a higher level of moisture under shrubs and trees, or even in the form of surface water, drainage lines represent an important refuge for species that are dependent on suitable microhabitat. These include SRE invertebrate species, which often accumulate along drainage lines, such as the burrowing spider *Idiosoma* `MYG244' or *Idiosoma* 'kalgoorlie' (Harvey, 2002; Rix *et al.*, 2018).

The Claypan, Flooplain and Saltbush Shrubland habitats are typically more restricted habitat types and are generally mapped to occupy smaller areas in comparison to other fauna habitat types such as Eucalypt Woodland dominated habitats (Terrestrial Ecosystem, 2016; Phoenix 2019). However, due to the presence of large salt lakes and clay pans in the Coolgardie region, they are relatively common in the area in particular to the south of the study areas near the TSF Area (McKenzie *et al.*, 1984; Phoenix Environmental Sciences, 2019).

4.3.2. Conservation Significant Fauna

All vertebrate fauna recorded during the survey are commonly recorded in the region. In total, four introduced mammal species, one native mammal, 19 bird species, and four reptiles were recorded. All of them are widespread and are known to occur at the study areas.

The database searches identified four mammal species and eighteen bird species as potentially occurring at the study areas. Of these, three bird species and two invertebrate fauna species have a moderate to high likelihood to occur within the study areas, with the remaining 17 species having a low likelihood to occur. Their details are listed in Table 4.4 and fauna species that has a moderate to high likelihood to occur are discussed in the below sections.

Table 4.4: Summary of Significant Fauna Species That Could Potentially Occur in the Study Area

Likelihood of Occurrence	Species	Conservation Status			Preferred habitats	Previous Records
		EPBC Act	WC/BC Act	DBCA		
Mammals						
Low The species is locally extinct in the region and the species is unlikely to occur.	Numbat *(Myrmecobius fasciatus)*	EN	EN	-	Eucalypt forests and woodlands, dominated by *Eucalyptus marginata*, *E. calophylla* and *E. wandoo*.	One record was made from Kalgoorlie (NatureMap). Two historical records from Kalgoorlie (Threatened Fauna Database).
Low Very limited and only historical records from the surrounding region. The species is known to be locally extinct in the region.	Greater Bilby *(Macrotis lagotis)*	VU	VU	-	Variety of habitats on soft soil including spinifex hummock grassland, acacia shrubland, open woodland and cracking clays.	Six historic records from Kalgoorlie and Kanowna (Threatened Fauna Database). No other records form the vicinity.
Low Although suitable woodland habitat exists within to the study areas, no records have been made in the surrounding area.	Chuditch, Western Quoll *(Dasyurus geoffroii)*	VU	VU	-	Sclerophyll forest, riparian forest, dry woodland, heath and mallee shrubland.	Protected Matter Search Tool (PMST) lists habitat to potentially be present within the study areas. Historical records from within 90 km of the study areas.
Low The study areas are outside the species' distribution. Highly unlikely to occur.	Western False Pipistrelle (*Falsistrellus mackenziei*)	-	-	P4	Sclerophyll forest of Karri, Jarrah and Tuart. Lives in old trees, branches and stumps.	A dead specimen was found in 2013 in Kalgoorlie. The species occurs in coastal regions of the south-west WA. Study areas are outside the species' range and no other records exist in the region.
Birds						
High Numerous records in close proximity of the study areas. Suitable habitat present, in particular at TSF Area and patches within the Rayjax study area.	Malleefowl *(Leipoa ocellata)*	VU	VU	-	Semi-arid and arid habitats. Variety of Mallee woodlands and shrublands.	Over 100 historic and recent records within 40 km of the study areas (DBCA, NatureMap 2019, Phoenix 2018).

Likelihood of Occurrence	Species	Conservation Status			Preferred habitats	Previous Records
		EPBC Act	WC/BC Act	DBCA		
Medium Four recent records (2016-2018) made from Kalgoorlie; however, study areas lie on the edge of the species' current range. Suitable habitat is present throughout the study areas.	Carnaby's Cockatoo *(Calyptorhynchus latirostris)*	EN	EN	-	Breeding in tree hollows of Wandoo, Tuart, Jarrah, York gum, Karri and Marri. Foraging in woodlands, forests, riparian vegetation, heath and *Banksia* woodland as well as introduced species.	Recently recorded from Kalgoorlie. Study areas lie on the north-eastern border of the species' current range.
Medium Recorded from the region of the study areas. Foraging habitat is present, no breeding habitat was recorded from the study areas.	Peregrine Falcon *(Falco peregrinus)*	-	OS	-	Widespread; coastal cliffs, riverine gorges and wooded watercourses.	One record from Credo station (26 km north-west of Castle Hill).
Low No suitable habitat present within the study areas. Records are scares in the region and limited to large inland wetlands.	Curlew Sandpiper *(Calidris ferruginea)*	CR	CR	-	Migratory/waterbird species are typically associated with coastal habitats. These species also inhabit inland ephemeral wetland habitat types when present.	Two records from saltlake habitat east and west of the study areas (Young River Station Lake & Kanowna). No other records in the vicinity.
Low No records in the area and habitat has not been recorded from the regional area. Species listed due to salt lake habitat present within the wider region (~100 km).	Night Parrot *(Pezoporus occidentalis)*	EN	EN	-	Most records from long unburnt *Triodia* grasslands and/or Chenopod shrublands featuring large dense clumps of vegetation.	No confirmed records in the area. Protected Matter Search Tool (PMST) lists habitat to potentially be present within the study areas.
Low The Fork-tailed Swift is highly nomadic and records are rare in the region. Records typically associated with suitable climatic conditions instead of habitat types.	Fork-tailed Swift *(Apus pacificus)*	M	M	-	Nomadic, almost entirely aerial lifestyle over a variety of habitats; associated with storm fronts.	Scattered records in the region but generally rarely recorded (NatureMap 2019).

Likelihood of Occurrence	Species	Conservation Status			Preferred habitats	Previous Records
		EPBC Act	WC/BC Act	DBCA		
Low No suitable habitat present within the study areas. Records are scarse in the region and limited to large inland wetlands.	Common Sandpiper *(Actitis hypoleucos)* Common Greenshank *(Actitis hypoleucos)* Sharp-tailed Sandpiper *(Calidris acuminata)* Wood Sandpiper *(Tringa glareola)* Ruddy Turnstone *(Arenaria interpres)* Red-necked Stint *(Calidris ruficollis)* Glossy Ibis *(Plegadis falcinellus)* Sanderling *(Calidris alba)* Grey-tailed Tattler *(Tringa brevipes)* Oriental Plover *(Charadrius veredrus)*	M	M	-	Migratory/waterbird species are typically associated with coastal habitats. These species also inhabit inland ephemeral wetland habitat types when present.	Several records from Kopai Lake, Rowles Lagoon, Young River Station Lake, Lake Douglas, Hannan Lake, and Kalgoorlie Sewerage Outlet. No other records from outside large lake or lagoon habitat.
Low No suitable habitat is present within the study areas. Two records in the region.	Hooded Plover *(Thinornis rubricollis)*	-	-	P4	Coastal areas and adjacent dunes. Also reefs, coastal lakes, and lagoons.	Two historical records from Arrow Lake from 1980 and 1992 (DBCA threatened fauna database).
Low	Blue-billed Duck *(Oxyura australis)*	-	-	P4	Wetland, inland lakes. Almost entirely aquatic lifestyle, rarely seen on land.	Records from Credo Station from 2015 (DBCA, NatureMap). No other

Likelihood of Occurrence	Species	Conservation Status			Preferred habitats	Previous Records
		EPBC Act	WC/BC Act	DBCA		
No suitable habitat is present within the study areas. Only one record in the region.						records within 100 km of the study area.
Invertebrates						
Medium Only historical records known from Lake Douglas; however, little is known about the species and suitable habitat is present at the study areas.	Arid Bronze Azure Butterfly *(Ogyris subterrestris petrina)*	CR	CR	-	Mallee Woodland and shrubland, hop-bush shrubland, often near flood plains. Associated with the sugar ant (*Camponotus terebrans*) at the base of smooth-barked trees and shrubs.	Known from only two locations, Barbalin NR in the Avon Wheatbelt (recent records) and from Lake Douglas (historical, 1911-1989), approx. 24 km south of the study areas. No other records exist in the area. Suitable habitat is present within study areas.
Medium Few records known to date from Lake Douglas; however, little is known about the species and suitable habitat is present at the study areas.	Inland Hairstreak (*Jalmenus aridus*)	-	-	P1	Larvae feeds on leaves and flowers of *Senna nemophila* and *Acacia tetragonophylla*. Adults remain close to breeding habitat.	Records are restricted to historical sightings in the 80s and 90s from Lake Douglas, approx. 24 km south of the study areas. No other records exist in the area. Suitable habitat is present within study areas.

4.3.2.1. Malleefowl (*Leipoa ocellata*)

Conservation Status: EPBC/BC Act Vulnerable

Distribution, Habitat and Ecology: Once common and widespread across semi-arid southern Australia, Malleefowl have declined severely in the last century, with a 50% decrease in area of occupancy (Benshemesh, 2007). Their current distribution is highly fragmented with a high risk of extinction (Benshemesh, 2007). Malleefowl inhabit habitats consisting of mallee thickets, mulga or other dense litter-forming shrublands as well as dry forest dominated by other eucalypt and acacia species (Johnstone and Storr, 1998; Benshemesh, 2007). They prefer sandy substrate with leaf litter to build their nesting mounds and, therefore the highest breeding density appears to be located in vegetation that is at least 40 years post fire (Woinarski, 1989; Benshemesh, 1990, 1992). They rarely breed in vegetation that has been burnt within the last 15 years.

Occurrence in the Study Areas: The Malleefowl was not recorded during the current survey. The species is known to occur in the region with recent records made from 2009 from 2.6 km west of the study area, also historic records from 1965 from (Figure 4.1). Suitable habitat was recorded from the TSF Area (Dense Shrubland) and from the Rayjax study area (denser patches within the Mixed Eucalypt Woodland). The species was recorded during the survey at Cutters Ridge just south of the Rayjax Haul Road (Phoenix 2019). The species is likely to breed in the region and may forage within the study areas. Suitable habitat provides optimal conditions for breeding and nesting activities as well as foraging with adjacent habitats potentially used for occasional foraging.

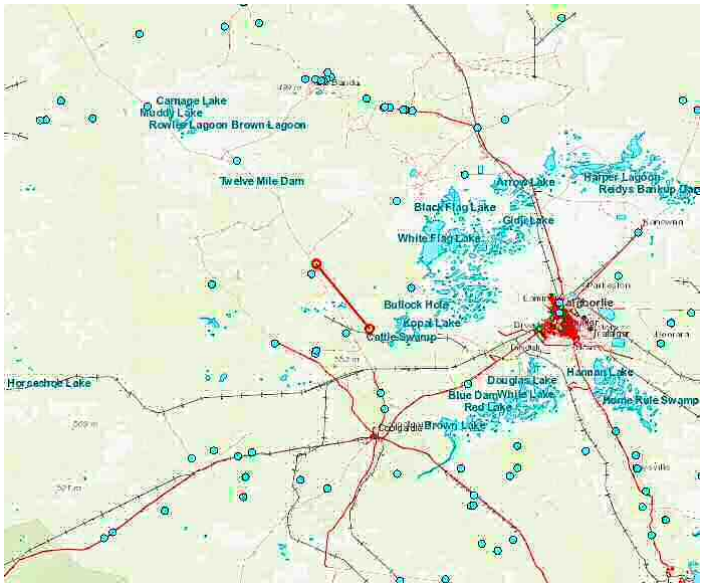


Figure 4.1: Regional Malleefowl Records (NatureMap 2019)

4.3.2.2. Carnaby's Cockatoo (*Calyptorhynchus latirostris*)

Conservation Status: EPBC/BC Act Endangered

Distribution, Habitat and Ecology: The Carnaby's Cockatoo is a woodland specialist. The species feeds on Kwongan heath, *Banksia* spp., *Hakea* spp., *Dryandra* spp., *Grevillea* spp., *Callistemom* spp., Marri, *Erodium* spp., wild radish, pecan nuts, insects as well as a range of fruits (apples etc) (CoA 2017). Roosting and breeding require the presence of large eucalypt trees and typically takes place in forests, woodlands or smaller groups of large trees. Pine plantations also represent an important food resource for Carnaby's Cockatoo with 65% of the Greater Perth-Peel Coastal Plain population recorded utilising the Gnangara Pine Plantation for roosting and foraging (Peck, Barrett and Williams, 2018).

Occurrence in the Study Areas: The Carnaby's Cockatoo has been recorded from Kalgoorlie in 2016 and 2017 (NatureMap, DBCA). However, the study area is outside the current mapped distribution and sightings are very rare in the surrounding (Figure 4.2). Habitat in the study areas and surrounding region provides suitable conditions for foraging, roosting and potential breeding but no actual sites for these activities are known from the region (Figure 4.2). Use of foraging habitat in the area may occur infrequently.

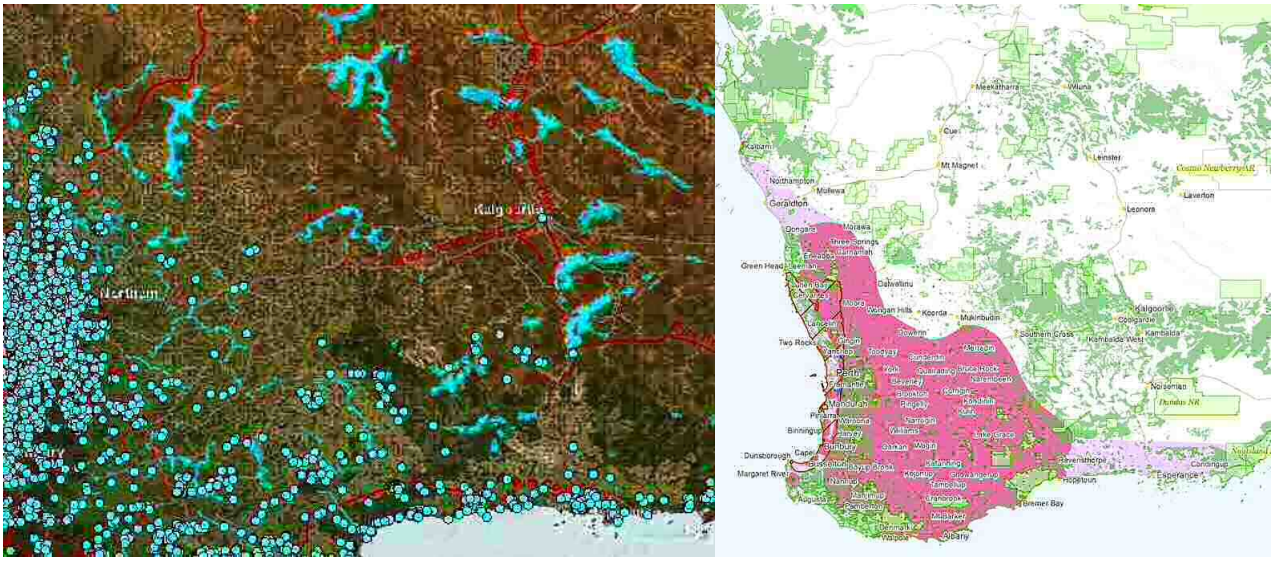


Figure 4.2: Regional Carnaby's Cockatoo Records (left) & Distribution Map (right)

4.3.2.3. Peregrine Falcon (*Falco peregrinus*)

Conservation Status: BC Act Other Specially Protected Fauna

Distribution, Habitat and Ecology: The Peregrine is a nomadic/sedentary bird which is widespread in many parts of Australia and some of its continental islands, but absent from most deserts and the Nullarbor Plain. The species is considered to be moderately common in the Stirling Range, uncommon in the Kimberley, Hamersley and Darling Ranges, and rare or scarce elsewhere (Johnstone and Storr, 1998). The Peregrine Falcon occurs breeds along cliffs, in particular along rivers and ranges, and forages over wooded watercourses and lakes. Peregrine Falcons feed almost entirely on birds, especially parrots and pigeons. They nest primarily on ledges on cliffs, granite outcrops and in quarries, but may also nest in tree hollows around wetlands. Eggs are predominantly laid in September (Johnstone and Storr, 1998).

Occurrence in the Study Areas: The Peregrine Falcon has been recorded from Credo station, approx. 26 km north-west of Castle Hill mine (Figure 4.3). More records exist to the north and north-west of Credo station. Some suitable foraging and hunting ground is present within the study areas; however, the majority of habitats are either too heavily vegetated (woodlands) or lack major drainage lines. The species may overfly the study areas on an occasional basis when travelling between breeding and hunting grounds. No breeding habitat is present within the study areas.

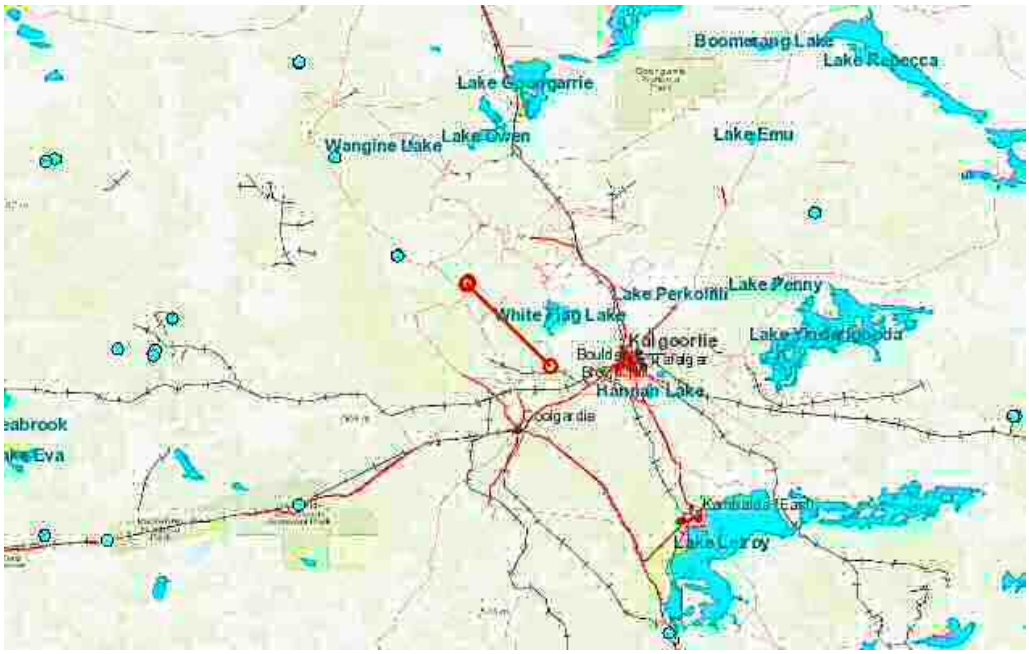


Figure 4.3: Regional Peregrine Falcon Records (NatureMap 2019)

4.3.2.4. Arid Bronze Azure Butterfly (*Ogyris subterrestris petrina*)

Conservation Status: EPBC/BC Act Critically Endangered

Distribution, Habitat and Ecology: To date, little is known about the Arid Bronze Azure Butterfly and all known records are restricted to two locations: Barbalin Nature Reserve, 11 km north-west of Mukinbudin in the central wheatbelt, and Lake Douglas near Kalgoorlie in the Goldfields region. The two locations are 320 km apart (Figure 4.4). The Arid Bronze Azure Butterfly is most likely associated with smooth barked eucalypt trees, such as Gimlet trees *Eucalyptus salubris* and the sugar ant *Camponotus terebrans* (Williams and Williams, 2008; Braby, 2016). The male and female adults have different upper surface, with the male being a plain dark purple with pale bronze margins, whereas the female is similar but with a black and white bar on the costa of each forewing (Williams and Williams, 2008; Braby, 2016). The butterflies have a wing span of about 3.5-4 cm. The eggs are laid in groups of about 40 on the base of mallee gum trees where there is typically an ant nest in the base. The pupa of the butterfly either crawls or will be carried into the ant nest where it is formed. The host ant is suggested to be the pale form of the sugar ant *Camponotus terebrans terebrans* (Williams and Williams, 2008; Braby, 2016).

Occurrence in the Study Areas: The occurrence of the Arid Bronze Azure Butterfly is highly determined by the distribution and abundance of the host ant *C. terebrans*. At the Barbalin site, the host ant has been found to be unicolonial, which means that all nests at Barbalin NR are part of a single 'super colony' (Australian Government, 2019).

In the study areas' surrounding, the Arid Bronze Azure Butterfly has been recorded from Lake Douglas, south-west of the Kalgoorlie. However, the records are all from 1911-1989 and no recent records have been made. There is little known about the species and it's lifestyle can be relatively elusive with small, 3.5-4cm sized adults only emerging between September and March (peak periods in mid-spring and late summer) (Braby, 2016; Australian Government, 2019).The Arid Bronze Azure Butterfly has a moderate likelihood to occur at the study areas based on the presence of potential habitat, the proximity to historic records, the elusive lifestyle and the general lack of knowledge of the species.

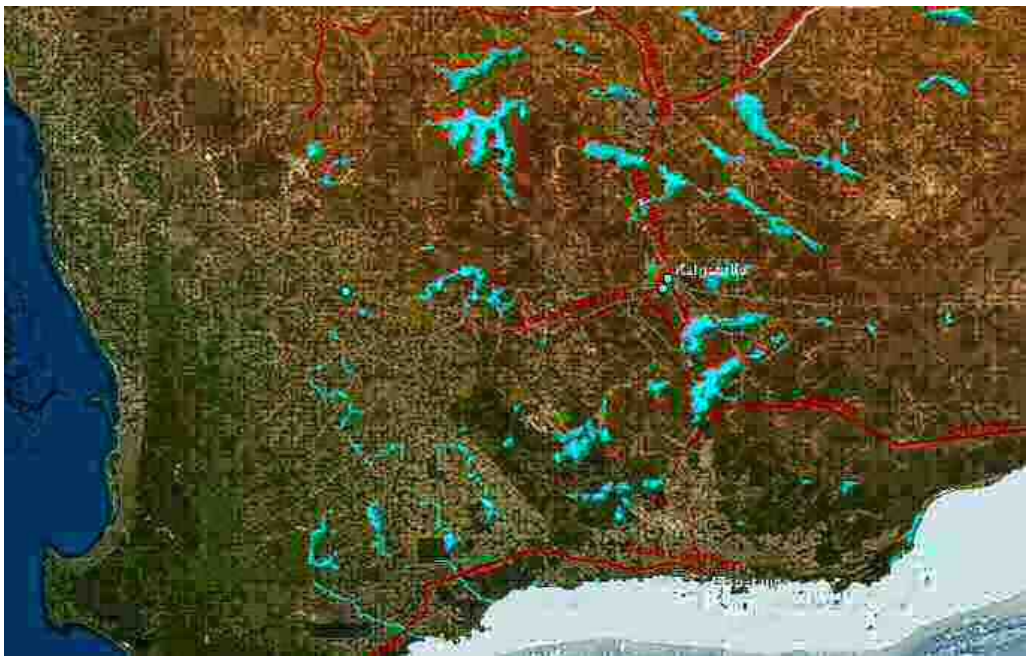


Figure 4.4: Regional Arid Bronze Azure Butterfly Records (NatureMap 2019)

4.3.2.5. Inland Hairstreak (*Jalmenus aridus*)

Conservation Status: DBCA Priority 1

Distribution, Habitat and Ecology: The Inland Hairstreak was originally described from Lake Douglas near Kalgoorlie, however, the species has not been recorded from this location since 1997. Based on the historical records, the larvae of this species is thought to feed on leaves and flowers of young shrubs of *Senna nemophila* and mature trees of *Acacia tetragonophylla*, which grow in shallow gullies with gentle slopes (Braby, 2016). The larvae of the butterfly are attended by the Froglet ant *Froggatella kirbii* (Figure 4.5). The adults are likely to be stay close to the breeding habitats. There are likely two generations per year, although adults are absent in some years (Braby, 2016).

Occurrence in the Study Areas: The Inland Hairstreak has a historic distribution in the close vicinity of the study areas and suitable habitat, in the form of host plants has been recorded from the study areas. Butterflies can be elusive, in particular during years when adults are absent. In general, invertebrate fauna species can be overlooked during survey work, and their distribution and ecology can be relatively unknown for a long time. There are only five records of this species known to date, all of which are from Lake Douglas. The species has not been recorded in WA since 1997 (DBCA 2019, DBCA). This lack of information, uncertainty of its distribution and the application of the Precautionary Principle leads to the conclusion that the species may occur in the study areas, at least on an infrequent basis.

Figure 4.5: Regional Inland Hairstreak Records (NatureMap 2019)

4.3.3. Invertebrate SRE Fauna

A total of 25 potential SRE invertebrate fauna species were recorded from the study area during the survey. Of these, nine pseudoscorpions, one geophilomorph, one centipede, three isopods, five millipedes, and six snails. No arachnids were collected which include mygalomorph spiders and scorpions. The two groups were targeted during foraging but no scorpions or mygalomorph spider burrows were recorded. This is not an unusual observation, with very few invertebrate species recorded during previous surveys (Phoenix 2019) and limited numbers of mygalomorph spiders (11 species) and scorpions (2 species) being returned in the database searches.

There was a moderate number of potential SRE invertebrate species recorded from the study areas which is comparable with records made during previous surveys in the region (Phoenix 2019). Generally, SRE invertebrate species can be difficult to determine due to the uncertainties in determining their distributions. This is often due to the lack of surveys, under-collection of species, lack of taxonomic resolution, and problems in identifying certain life stages. Even when invertebrate species are collected, the majority of them are unknown, undescribed or poorly represented, therefore leaving uncertainties about their status and distribution outside the study areas (Harvey, 2002; Harewood, 2014a).

The taxa currently regarded as `*Antichiropus* sp.' (Diplopoda; Paradoxosomatidae) cannot be fully assessed for SRE status until adults of the millipede (*Antichiropus* sp.) have been collected.

The snail `*Basedowena* cf. *holoserica*' (Mollusc; Camaenidae) was collected from each of the study areas. Based on its differences in morphology, it may represent a new species; however, it resembles *Basedowena holoserica*. Genetic analysis would be required to determine the species and/or if the specimens are unique to what has previously been recorded within the region.

Although limited, the current information for the remaining taxa indicates that there is a reasonable likelihood that they may be range restricted, therefore they are considered Potential SREs as a precaution.

In the absence of firm taxonomic identifications, it is reasonable to use habitats as a surrogate to assess the likelihood of occurrence and potential impacts the development posed to potential SRE invertebrate species. All habitat types recorded from the study areas are not known to be invertebrate fauna hot spots, with the only exception of the Minor Drainage Lines.

Yen and Butcher (1997) list the following threats to SRE invertebrate fauna species include:

- Agriculture and clearing of native vegetation
- Habitat fragmentation
- Grazing and trampling
- Inappropriate fire regimes
- Forestry activities
- Pollution
- Pests and diseases
- Alterations to aquatic ecosystems
- Mineral extraction
- Transport and recreation
- Exotics and introduced taxa
- Direct exploitation
- Long-term environmental changes, including climate change arising from the enhanced Greenhouse Effect.

5. CONCLUSIONS

5.1. Castle Hill

5.1.1. Flora

No Threatened or other significant flora taxa were recorded at the Castle Hill study area during the current assessment. One Priority 1 flora species, *Eremophila praecox*, was given a high likelihood of occurrence at the Castle Hill study area (vegetation type iv).

5.1.2. Vegetation

There were no vegetation types identified as significant due to being considered a TEC or PEC. Vegetation type viii was considered significant because it was restricted in the study area and type iv was considered significant because it provides refugee to a P1 flora species. Neither of these were considered to have high local or regional significance.

5.1.3. Fauna

No conservation significant fauna was recorded from the Castle Hill study area. Thirteen potential SRE taxa were recorded, of which one species, a snail, *Basedowena* cf. *holoserica*, may represent a new species. All habitat types recorded are common in the region and are not restricted to the Castle Hill study area. The Minor Drainage Line habitat may represent the most significant due to the ability to be a refuge for SRE invertebrate species.

5.2. Rayjax

5.2.1. Flora

No Threatened or other significant flora taxa were recorded at the Rayjax study area during the current assessment. One Priority 1 flora species, *Eremophila praecox*, was given a high likelihood of occurrence at the Rayjax study area (vegetation type iv).

5.2.2. Vegetation

There were no vegetation types identified as significant due to being considered a TEC or PEC. Vegetation type vi was considered significant because it was restricted in the study area and type iv was considered significant because it provides refuge to a P1 flora species. Neither of these were considered to have high local or regional significance.

5.2.3. Fauna

No conservation significant fauna was recorded from the Rayjax study area. Nine potential SRE taxa were recorded, of which one species, a snail *Basedowena* cf. *holoserica*, may represent a new species. The millipedes, *Antichiropus* sp., could not be identified to species level due to the specimens being juveniles. All habitat types recorded are common in the region and are not restricted to the Rayjax study area.

5.3. Burgundy to Cutters Ridge Haul Road

5.3.1. Flora

No Threatened flora taxa were recorded during the current assessment or considered likely to occur at the Burgundy to Cutters Ridge Haul Road study area. One Priority 3 taxa, *Allocasuarina eriochlamys* subsp. *grossa*, was recorded from 480 m west of the study area during the current assessment and was assigned a low local and regional significance. One Priority 1 flora species, *Eremophila praecox*, recorded at the Haul Road study area during the desktop assessment and was assigned a low local and regional significance at the study area.

One species of interest was recorded at relevé R116: a specimen of *Eremophila* sp? which could not be fully identified. Coordinates have been provided electronically.

5.3.2. Vegetation

There were no vegetation types identified as significant due to being considered a TEC or PEC. Vegetation type vii was considered significant because it was restricted in the study area and has potential to provide refuge for a P4 flora species (*Eucalyptus jutsonii* subsp. *jutsonii*) and a species of interest (*Calandrinia* sp. Gypsum), and is considered to have high local and regional significance. Type iv was considered significant because it provides refugee to a P1 flora species.

5.3.3. Fauna

No conservation significant fauna was recorded from the Burgundy to Cutters Ridge Haul Road study area. Eleven potential SRE taxa were recorded, of which one species, a snail *Basedowena* cf. *holoserica*, may represent a new species. All habitat types recorded are not restricted to the study area, with the Floodplain and Minor Drainage Line being the more restricted habitat types. The Minor Drainage Line has the highest potential to harbour SRE invertebrate fauna species, whereas the other habitat types do not typically provide suitable microhabitats.

5.4. TSF

5.4.1. Flora

No Threatened or other significant flora taxa were recorded at the TSF study area during the current assessment. Two Priority 1 flora species, *Eremophila praecox* and *Calandrinia lefroyensis/quartzitica* were given a high likelihood of occurrence. *Calandrinia lefroyensis/quartzitica* is considered to have high local and regional significance. One environmental weed species was recorded just outside the TSF study area: **Erodium cicutarium*.

5.4.2. Vegetation

There were no vegetation types identified as significant due to being considered a TEC or PEC. Vegetation types ii, iii and xi were considered significant because they were restricted in the study area, types ii and v provided refugee to the complex *Tecticornia* group and iv was considered significant because it provides refugee to a P1 flora species. Vegetation types ii and v were considered to have a high local significance.

5.4.3. Fauna

No conservation significant fauna was recorded from the TSF study area. Five potential SRE taxa were recorded, of which one species, a snail *Basedowena* cf. *holoserica*, may represent a new species. All habitat types recorded are not restricted to the study area, with the dense shrubland habitat type considered

significant because it provides suitable conditions to the Malleefowl which is likely to be breeding or foraging in the area.

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Appendix A: Likelihood of Occurrence of Significant Flora

Likelihood	Status	Family	Species	Distance from Study Area (km)	Habitat	Source		
						WA Herb	TPFL	Reports Phoenix
Recorded	3	Casuarinaceae	*Allocasuarina eriochlamys subsp. grossa*	1	Red clay and laterite.	2	-	1
Recorded	1	Montiaceae	*Calandrinia sp ?lefroyensis/quartzitica*	<1	Red Sandy ecotone	-	-	2
Recorded	1	Scrophulariaceae	*Eremophila praecox*	<1	Low plain, red-brown sandy loam.	6	10	2
High	SOI	Montiaceae	*Calandrinia sp. Gypsum*	<1	Floodplain with chenopod shrubland on sandy/loamy clay	-	-	1
High	4	Myrtaceae	*Eucalyptus jutsonii subsp. jutsonii*	12	Red sandy soil.	3	-	-
High	3	Poaceae	*Austrostipa blackii*	<1	Basalt or BIF with red-brown deep sandy clay loam soils	1	-	1
Medium	3	Asteraceae	*Chrysocephalum apiculatum subsp. norsemanense*	19	Red sand.	1	-	-
Medium	2	Asteraceae	*Elachanthus pusillus*	22	Unknown	1	-	-
Medium	1	Asteraceae	*Rhodanthe uniflora*	31	Brown earth. Open eucalyptus woodland.	1	-	-
Medium	3	Asteraceae	*Notisia intonsa*	3	Red-brown sandy loam- light clay. Lake shore saline soils	8	2	-
Medium	3	Brassicaceae	*Phlegmatospermum eremaeum*	19	Stony loam.	1		-
Medium	1	Fabaceae	*Acacia websteri*	20	Flat, lateritic soil in red clay sand.	13	5	-
Medium	T	Fabaceae	*Gastrolobium graniticum*	19	Granite rocks in red sand	33	2	-
Medium	T	Haemodoraceae	*Conostylis lepidospermoides*	14	Grey or yellow-brown sand over laterite	1	-	-
Medium	1	Myrtaceae	*Thryptomene sp. Londonderry (R.H. Kuchel 1763)*	19	Orange - brown stony to sandy loams. Sandy flats.	11	-	-
Medium	4	Scrophulariaceae	*Eremophila caerulea subsp. merrallii*	11	Sand, clay or loam. Undulating plains	1	-	-
Low	1	Amaranthaceae	*Ptilotus chortophytus*	22	Quartz outcrop	2	-	-
Low	1	Amaranthaceae	*Ptilotus procumbens*	24	Deep red clay.	1	-	-
Low	3	Apocynaceae	*Alyxia tetanifolia*	18	Sandy clay, loam, concretionary gravel. Drainage lines, near lakes	4	1	-
Low	3	Asteraceae	*Angianthus prostratus*	32	Red loamy soil	3	-	-
Low	3	Brassicaceae	*Lepidium fasciculatum*	23	Dry lake bed. Flat. Soil red loam.	2	-	-
Low	2	Brassicaceae	*Lepidium merrallii*	19	Ridge/slope. Well-drained. Dry brown clay loam over granite. 10-30% of loose rock on soil surface.	1	-	-
Low	3	Chenopodiaceae	*Atriplex lindleyi subsp. conduplicata*	27	By lake.	1	-	-
Low	3	Cyperaceae	*Eleocharis papillosa*	50	Winter wet claypan. Red brown clay loam.	1	-	-
Low	3	Cyperaceae	*Isolepis australiensis*	25	Plain. Seasonally wet red clay soils. Low lying damp area.	1	-	-
Low	1	Cyperaceae	*Lepidosperma sp. Parker Range (N. Gibson & M. Lyons 2094)*	29	Unknown	1	-	-
Low	3	Ericaceae	*Styphelia sp. Bullfinch (M. Hislop 3574)*	36	Red brown loamy clay. Granite rocks with occasional quartz ground cover	2	-	-
Low	1	Ericaceae	*Melichrus sp. Coolgardie (K.R. Newbey 8698)*	36	Yellow sandplain.	3	-	-
Low	1	Euphorbiaceae	*Ricinocarpos sp. Eastern Goldfields (A. Williams 3)*	34	Yellow sand	1	-	-

Likelihood	Status	Family	Species	Distance from Study Area (km)	Habitat	Source		
						WA Herb	TPFL	Reports Phoenix
Low	1	Fabaceae	*Acacia coatesii*	25	Skeletal red loam, Laterite/quartz, green stone ridge. Flat to gentle slope- low rocky hill	5	-	-
Low	3	Fabaceae	*Acacia crenulata*	32	Flat plain with red brown sandy loam - clay loam soil	6	2	-
Low	3	Fabaceae	*Acacia cylindrica*	39	Flat sandplain with very few laterite/quartz fine gravel on deep yellow sandy soil.	1	-	-
Low	1	Fabaceae	*Acacia epedunculata*	42	Yellow sand on sandplain.	8	4	-
Low	1	Fabaceae	*Acacia sclerophylla var. teretiuscula*	30	Clay and loamy soils	1		-
Low	3	Fabaceae	*Gompholobium cinereum*	6	Gentle undulations, yellow sand over laterite.	1	1	-
Low	4	Frankeniaceae	*Frankenia glomerata*	22	Saline depression. White sand.	1	-	-
Low	1	Goodeniaceae	*Dampiera plumosa*	28	Red sandy soils.	1	-	-
Low	2	Goodeniaceae	*Goodenia salina*	25	Flat drainage system. Red sandy clay loam over low gypseous sandy rise.	1	-	-
Low	4	Haloragaceae	*Myriophyllum petraeum*	45	Granitic silty sand. Floor of small ephemeral pool on granite bedrock exposure, water 10-12 cm deep	2	1	-
Low	3	Myrtaceae	*Calytrix creswellii*	44	Flat sandplain of deep yellow sandy soil.	1	-	-
Low	3	Myrtaceae	*Cyathostemon verrucosus*	23	Unknown	1	-	-
Low	2	Myrtaceae	*Eucalyptus educta*	10	Rocky Granite slope and gullies. Brown loam	4	-	-
Low	1	Myrtaceae	*Eucalyptus websteriana subsp. norsemanica*	29	Hill. Rocky, greenstone, metamorphosed basalt.	2	-	-
Low	4	Myrtaceae	*Eucalyptus x brachyphylla*	22	Granite rocks.	1	-	-
Low	3	Myrtaceae	*Hysterobaeckea ochropetala subsp. cometes*	46	Flat plain. Soil red sandy loam.	2	-	-
Low	3	Myrtaceae	*Melaleuca coccinea*	24	Sandy loam over granite. Granite outcrops, sandplain, river valleys	1	-	-
Low	3	Myrtaceae	*Rinzia triplex*	42	Plain. Red-brown Yellow sandy clay loam with lateritic gravel.	3	-	-
Low	1	Myrtaceae	*Thryptomene sp. Coolgardie (E. Kelso s.n. 1902)*	19	Unknown	2	-	-
Low	3	Parmeliaceae	*Xanthoparmelia dayiana*	35	Laterite outcrops. On laterite pebbles.	3	-	-
Low	1	Parmeliaceae	*Xanthoparmelia subbarbatica*	34	Growing on rocks. Ridgetop with greenstone rubble on surface.	1	-	-
Low	1	Poaceae	*Austrostipa sp. Carlingup Road (S. Kern & R. Jasper LCH 18459)*	29	Basalt with red-brown shallow sandy clay soils	3	-	-
Low	2	Poaceae	*Austrostipa sp. Dowerin (G. Wiehl F 8004)*	30	Basalt with red-brown shallow sandy clay loam soils.	2	-	-
Low	2	Polygonaceae	*Rumex crystallinus*	27	Moist soil near water.	1	-	-
Low	3	Proteaceae	*Grevillea georgeana*	23	Top of sand dune. Yellow sand.	1	1	-
Low	2	Proteaceae	*Hakea rigida*	10	Sandy soils, yellow sand	1	-	-
Low	1	Rutaceae	*Philotheca pachyphylla*	36	Sand, red loam, clay loam. Sandplains, hill tops	6	-	-
Low	1	Rutaceae	*Phebalium appressum*	8	Yellow-brown sand-loam. Sandplain	2	-	-

Likelihood	Status	Family	Species	Distance from Study Area (km)	Habitat	Source		
						WA Herb	TPFL	Reports Phoenix
Low	2	Rutaceae	*Phebalium clavatum*	35	Sandplain, red/brown loamy sand over granite.	10	2	-
Low	3	Scrophulariaceae	*Diocirea acutifolia*	42	Flat of red/brown clay loam	1	-	-
Low	3	Scrophulariaceae	*Diocirea microphylla*	34	Plain to gentle slope. Red brown clay loam.	11	-	-
Low	3	Scrophulariaceae	*Eremophila veronica*	21	Stony clay, clay loam. Lateritic breakaways. Party disturbed area/ drainage area	9	-	-
Low	1	Scrophulariaceae	*Eremophila xantholaema*	44	Slope. Brown/red rocky loam/granite.	3	-	-

Appendix B: Relevé/Quadrat Site Data Collection Sheet

Details included in Relevé Sampling

- Site code, date; location;
- Botanist;
- Photograph;
- Vegetation condition (as defined in Table 2.2);
- Disturbances (grazing, weeds, tracks, mounds, litter, erosion, clearing etc.);
- Time since fire (<1 year, 1-2 years, 2-5 years, >5 years); and
- Landform, geology and soils, consistent with the Australian soils and land survey field handbook (National Committee on Soil and Terrain, 2009), including:

  - Flat: plain
  - Flat: valley floor
  - Flat: tidal
  - Slope: lower, mid, upper
  - Slope: cliff
  - Slope: simple
  - Slope: simple dune
  - Hillock
  - Crest: hill
  - Crest: dune
  - Crest: mesa
  - Ridge: hill
  - Ridge: dune
  - Open depression: drainage line
  - Open depression: creek/river
  - Open depression: floodplain
  - Closed depression: Lake edge
  - Closed depression: Swamp edge
  - Drainage line on slope: lower, mid, upper

  - Slope: Level <1°, Very gentle 1°, Gentle 3°, Moderate 10°, Steep 23°, Very steep 37°, Precipitous 60° and Cliff 80°;
  - Aspect: North, South, East, West;
  - Soil: Sand, Clay, Loam, Sandy-clay, Hard-clay, Cracking-clay and Saline;
  - Soil Colour: Dark, Light, Red, Orange, White, Grey, Brown, Black and Yellow;
  - Rock Type: BIF, Calcrete, Creek stones, Dolerite, Granite, Ironstone, Shale, Quartz and Other;
  - Rock Abundance: No rocks, Very few (<2%), Few (2-10%), Common (10-20%), Many (20-50%), Abundant (50-90%) and Continuous (>90%); and
  - Rock Size: Fine gravel (<6 mm), Medium gravel (6-20 mm), Coarse gravel (20-60 mm), Cobbles (60-200 mm), Stones (200-600 mm) and Boulders (>600 mm).
- Dominant species – Crown cover (%) and Height (m); and
- Vegetation structure - NVIS Level V: three dominant species in three strata: upper, middle and ground (ESCAVI, 2003).

Appendix C: Relevé Site Data

Site: R104	Site Type: Releve	Date: 21/8/2019	Botanist: CF
Study area:	TSF		
Landform:	Flat: Plain		
Slope, aspect:	Level <1o		
Soil:	Red Sand; Clay;		
Rocks:	No rocks		
Abundance:			
Size:			
Fire:	>5 years		
Condition:	Excellent		
Notes:	Grazing (low);		
Veg Unit:	iv		
Location:	51J 0330402 6596335		
Vegetation description:			
Eucalyptus salubris and *E. clelandiorum* open mallee woodland over *Eremophila scoparia*, *Senna artemisiodes* ssp. *Filifolia* and *Cratystylis conocephala* open shrubland over *Olearia muelleri* isolated heath shrubs.			

Site: 105	Site Type: Releve	Date: 21/8/2019	Botanist: CF
Study area:	TSF		
Landform:	Flat: Plain		
Slope, aspect:	Level <1o		
Soil:	Red Sand;		
Rocks:	No rocks		
Abundance:			
Size:			
Fire:	>5 years		
Condition:	Excellent		
Notes:	Tracks;		
Veg Unit:	v		
Location:	51J 0330167 6596066		
Vegetation description:			
Melaleuca lateriflora open shrubland			

Site: 106	Site Type: Releve	Date: 21/8/2019	Botanist: CF
Study area:	TSF		
Landform:	Drainage: Floodplain		
Slope, aspect:	Level <1o		
Soil:	Red Sand; Clay;		
Rocks:	No rocks		
Abundance:			
Size:			
Fire:	>5 years		
Condition:	Excellent		
Notes:	Grazing (low);		
Veg Unit:	v		
Location:	51J 0329795 6596051		
Vegetation description:			
Frankenia setosa and *Atriplex stipitata* open heathland			

Site:107	Site Type: Releve	Date: 21/8/2019	Botanist: CF
Study area:	TSF		
Landform:	Drainage: Salt Pan		
Slope, aspect:	Level <1o		
Soil:	Red Cracking Clay;		
Rocks:	No rocks		
Abundance:	-		
Size:	-		
Fire:	>5 years		
Condition:	Excellent		
Notes:	Drainage: Salt Pan		
Veg Unit:	ii		
Location:	51J 0329616 6596084		
Vegetation description			
Tecticornia sp. open chenopod shrubland			

Site:108	Site Type: Releve	Date: 22/08/2019	Botanist: CF
Study area:	TSF		
Landform:	Flat: Plain		
Slope, aspect:	Very Gentle 1o		
Soil:	Red Sand; Clay;		
Rocks:	No rocks		
Abundance:	-		
Size:	-		
Fire:	>5 years		
Condition:	Excellent		
Notes:	Grazing (low); Tracks; Partial clearing;		
Veg Unit:	iii		
Location:	51J 0330603 6595067		
Vegetation description			
Eucalyptus yilgarnensis, *E. salubris* and *E. clelandiorum* mallee woodland over *Eremophila scoparia*, *Senna artemisiodes* ssp. *filifolia* open shrubland over *Ptilotus obovatus* isolated heath shrubs			

Site: 109	Site Type: Releve	Date: 22/08/2019	Botanist: CF
Study area:	TSF		
Landform:	Drainage: Salt Pan		
Slope, aspect:	Level <1o		
Soil:	Light; Orange; Clay		
Rocks:	No rocks		
Abundance:	-		
Size:	-		
Fire:	>5 years		
Condition:	Good		
Notes:	Grazing (low); kangaroo. Many dead mixed herbs.		
Veg Unit:	xi		
Location:	51J 0329394 6595917		
Vegetation description			
Duma florulenta sparse shrubland			

Site: R110	Site Type: Releve	Date: 22/08/2019	Botanist: CF
Study area:	Rayjax		
Landform:	Flat: Plain		
Slope, aspect:	Level <1o		
Soil:	Red Sand; Clay;		
Rocks:	No rocks		
Abundance:	-		
Size:	-		
Fire:	>5 years		
Condition:	Excellent		
Notes:	Grazing (low); some water movement		
Veg Unit:	iv		
Location:	51J 0320942 6595409		
Vegetation description			
Eucalyptus clelandiorum and *E.* (R111-2/R110-1) mallee woodland over *Eremophila scoparia*, *Senna artemisiodes* ssp. *Filifolia* and *Atriplex nummularia* ssp. *spathulata* and *Acacia hemiteles* open shrubland over *Acacia nyssophylla* sparse heathland.			

Site: R111	Site Type: Releve	Date: 22/08/2019	Botanist: CF
Study area:	Rayjax		
Landform:	Flat: Plain		
Slope, aspect:	Level <1o		
Soil:	Red Sand; Clay;		
Rocks:	No rocks		
Abundance:	-		
Size:	-		
Fire:	>5 years		
Condition:	Excellent		
Notes:	-		
Veg Unit:	iv		
Location:	51J 0321304 6595192		
Vegetation description			
Eucalyptus griffithsii and *E.* (R111-2) mallee woodland over *Acacia hemiteles* and *Senna artemisioides* ssp. *Filifolia* open shrubland.			

Site: R118	Site Type: Releve	Date: 24/08/2019	Botanist: CF
Study area:	Rayjax		
Landform:	Hill Slope: Simple		
Slope, aspect:	Gentle 3o		
Soil:	Red Brown sandy Clay		
Rocks:	Ironstone; Quartz		
Abundance:	Abundant 50-90%		
Size:	60-200 mm Cobbles;		
Fire:	>5 years		
Condition:	Very Good		
Notes:	Tracks; Litter		
Veg Unit:	vi		
Location:	51J 0323138 6595541		
Vegetation description			
Eucalyptus moderata open woodland over *E. oleosa* and *E. torquata* mallee woodland over *Eremophila pustulata* and *Eremophila interstans* ssp. *Interstans* sparse shrubland over Acacia erinacea, Senna artimisioides ssp. Filifolia, Atriplex vesicaria, Cratystylis conocephala and *Olearia muelleri* sparse heathland			

Site: MN04	Site Type: Mapping Note	Date: 23/08/2019	Botanist: CF
Study area:	B-C HR		
Landform:	Drainage: Creek/River		
Slope, aspect:	Gentle 3o		
Soil:	Red Sand; Clay;		
Rocks:	Laterite; Quartz		
Abundance:	Very few <2%		
Size:	Pebbles		
Fire:	>5 years		
Condition:	Excellent		
Notes:	-		
Veg Unit:	iv		
Location:	51J 0315281 6605986		
Vegetation description			
Eucalyptus campaspe and *E. salmonophloia* open mallee woodland over *Eremophila interstans* ssp. *Interstans* and *E. scoparia* open shrubland over *Atriplex ?stipitata* and *Ptilotus obovatus* sparse healthland			

Site: MN05	Site Type: Mapping Note	Date: 24/08/2019	Botanist: CF
Study area:	B-C HR		
Landform:	Flat: Plain		
Slope, aspect:	Level <1o		
Soil:	Red Sand; Clay;		
Rocks:	No rocks		
Abundance:	-		
Size:	-		
Fire:	>5 years		
Condition:	Excellent		
Notes:	-		
Veg Unit:	iv		
Location:	51J 0315281 6605986		
Vegetation description			
Eucalyptus clelandiorum and *E. salmonophloia* woodland over *Atriplex nummularia* and *A. vesicaria* sparse heathland.			

Site: R114	Site Type: Releve	Date: 23/08/2019	Botanist: CF
Study area:	B-C HR		
Landform:	Hill Slope: Simple		
Slope, aspect:	Moderate		
Soil:	Red Orange Clay		
Rocks:	Laterite; Quartz		
Abundance:	Continuous >90%		
Size:	<6 mm - Fine Gravel;		
Fire:	>5 years		
Condition:	Excellent		
Notes:	-		
Veg Unit:	iv		
Location:	51J 0315306 6606001		
Vegetation description			
Eucalyptus clelandiorum woodland over *Eremophila intersans* ssp. *Interstans* sparse shrubland over *Atriplex ?stipitata* sparse heathland.			

Site: R115	Site Type: Releve	Date: 24/08/2019	Botanist: CF
Study area:	B-C HR		
Landform:	Flat: Plain		
Slope, aspect:	Level <1o		
Soil:	Red Sand; Clay;		
Rocks:	Ironstone; Quartz		
Abundance:	Common 10-20%		
Size:	<6 mm - Fine Gravel;		
Fire:	>5 years		
Condition:	Excellent		
Notes:	Tracks		
Veg Unit:	iv		
Location:	51J 0317844 6603496		
Vegetation description			
Eucalyptus clelandiorum and *E. salmonophloia* woodland over *E. salubris* open mallee woodland over *Atriplex nummularia* and *A. vesicaria* open heathland.			

Site: R116	Site Type: Releve	Date: 24/08/2019	Botanist: CF
Study area:	B-C HR		
Landform:	Flat: Plain		
Slope, aspect:	Very Gentle		
Soil:	Red Sand; Clay;		
Rocks:	Ironstone; Quartz		
Abundance:	Many 20-50%		
Size:	<6 mm - Fine Gravel;		
Fire:	>5 years		
Condition:	Excellent		
Notes:	Tracks. Vege asat R115		
Veg Unit:	iv		
Location:	51J 0320766 6600159		
Vegetation description			
Eucalyptus salubris and *E. salmonophloia* woodland over *E. torquata* open mallee woodland over *Eremophila scoparia* sparse shrubland over *Cratystylis conocephala*, *Olearia muelleri* and *Atriplex ?stipitata* sparse heathland			

Site: R117	Site Type: Releve	Date: 24/08/2019	Botanist: CF
Study area:	B-C HR		
Landform:	Flat: Plain		
Slope, aspect:	Very Gentle		
Soil:	Red Orange Sand; Clay;		
Rocks:	Ironstone;		
Abundance:	Few 2-10%		
Size:	<6 mm - Fine Gravel;		
Fire:	>5 years		
Condition:	Excellent		
Notes:	-		
Veg Unit:	vii		
Location:	51J 0322475 6598832		
Vegetation description			
Casuarina obesa open woodland over *Eucalyptus griffithsii* mallee woodland over *Senna artemisioides* and *Eremophila ionantha* sparse shrubland over *Acacia hemiteles* and *Grevillea acuaria* sparse healthland			

Site: MN01	Site Type: Mapping Note	Date: 23/08/2019	Botanist: CF
Study area:	C Hill		
Landform:	Flat plain		
Slope, aspect:	Level <1o		
Soil:	Red Clay		
Rocks:	Ironstone;		
Abundance:	Few 2-10%		
Size:	6-20 mm Medium Gravel;		
Fire:	>5 years		
Condition:	Very Good		
Notes:	Tracks;		
Veg Unit:	x		
Location:	51J 0312909 6607653		
Vegetation description			
Acacia burkittii and *Eremophila scoparia* open shrubland.			

Site: MN02	Site Type: Mapping Note	Date: 23/08/2019	Botanist: CF
Study area:	C Hill		
Landform:	Flat: Plain		
Slope, aspect:	Very Gentle		
Soil:	Red Sand; Clay;		
Rocks:	Ironstone;		
Abundance:	Few 2-10%		
Size:	<6 mm - Fine Gravel;		
Fire:	>5 years		
Condition:	Very Good		
Notes:	Tracks. Vege As at MN01		
Veg Unit:	x		
Location:	51J 0314011 6607674		
Vegetation description			
Eucalyptus griffithsii open woodland over *Acacia burkittii* and *Atriplex nummularia* ssp. *spathulata* open shrubland.			

Site: MN03	Site Type: Mapping Note	Date: 23/08/2019	Botanist: CF
Study area:	C Hill		
Landform:	Flat: Plain		
Slope, aspect:	Very Gentle		
Soil:	Red Sand; Clay;		
Rocks:	Ironstone;		
Abundance:	Very few <2%		
Size:	<6 mm - Fine Gravel;		
Fire:	>5 years		
Condition:	Very Good		
Notes:	-		
Veg Unit:	viii		
Location:	51J 0314465 6607880		
Vegetation description			
Eucalyptus griffithsii mallee woodland over *Eremophila scoparia*, *E. interstans* ssp. *Virgata* and *Acacia hemiteles* open shrubland			

Site: OC020 MN	Site Type: Mapping Note	Date: 23/08/2019	Botanist: CF
Study area:	C Hill		
Landform:	Drainage: Drainage line on flat		
Slope, aspect:	Gentle 3o		
Soil:	Red Sand; Clay;		
Rocks:	Granite		
Abundance:	Few 2-10%		
Size:	6-20 mm Medium Gravel;		
Fire:	>5 years		
Condition:	Very Good		
Notes:	Tracks;		
Veg Unit:	x		
Location:	51J 0311995 6607761		
Vegetation description			
Acacia burkittii open shrubland			

Site: R112	Site Type: Releve	Date: 23/08/2019	Botanist: CF
Study area:	C Hill		
Landform:	Flat: Plain		
Slope, aspect:	Very Gentle		
Soil:	Red Sand; Clay;		
Rocks:	Quartz, Ironstone;		
Abundance:	Common 10-20%		
Size:	6-20 mm Medium Gravel;		
Fire:	>5 years		
Condition:	Very Good		
Notes:	Tracks;		
Veg Unit:	i		
Location:	51J 0311258 6609056		
Vegetation description			
Eucalyptus ?capillosa, *E. campaspe* and *E. salmonophloia* open mallee woodland over *Atriplex nummularia* ssp. *spathulata* and *Eremophila interstans* ssp. *Interstans* sparse shrubland over *Atriplex vesicaria* sparse heathland			

Site: R113	Site Type: Releve	Date: 23/08/2019	Botanist: CF
Study area:	C Hill		
Landform:	Drainage: Creek/River		
Slope, aspect:	Moderate 10o		
Soil:	Red Sand; Clay;		
Rocks:	Calcrete; Creek stones		
Abundance:	Many 20-50%		
Size:	60-200 mm Cobbles;		
Fire:	>5 years		
Condition:	Good		
Notes:	Tracks; Partial clearing;		
Veg Unit:	ix		
Location:	51J 0311905 6607367		
Vegetation description			
Eucalyptus clelandiorum mallee woodland over *Eremophila scoparia*, *Acacia burkittii* and *Atriplex nummularia* ssp. *spathulata* sparse shrubland			

Appendix D: Species List - Flora

Family	Species
Aizoaceae	*Disphyma crassifolium*
	Gunniopsis quadrifida
	Sarcozona praecox
	Tetragonia eremaea
Amaranthaceae	?*Ptilotus* sp.
	Ptilotus carlsonii
	Ptilotus exaltatus
	Ptilotus holosericeus
	Ptilotus obovatus
Apocynaceae	*Alyxia buxifolia*
Asteraceae	*Brachyscome ciliaris*
	Centipeda crateriformis
	Cratystylis microphylla
	Cratystylis conocephala
	Olearia muelleri
	Olearia pimeleoides
	Podolepis capillaris
	Senecio glossanthus
	Senecio spanomerus
	Thiseltonia gracillima
Brassicaceae	*Stenopetalum filifolium*
Casuarinaceae	*Allocasuarina eriochlamys* subsp. *grossa* (Priority 3)
	Casuarina ?*obesa*
	Casuarina obesa
	Casuarina pauper
Chenopodiaceae	*Atriplex* ?*stipitata*
	Atriplex nummularia
	Atriplex nummularia subsp. *spathulata*
	Atriplex vesicaria
	Maireana ?*erioclada*
	Maireana ?*georgei*
	Maireana amoena
	Maireana appressa
	Maireana georgei
	Maireana sedifolia
	Maireana trichoptera
	Maireana triptera
	Rhagodia drummondii
	Sclerolaena drummondii
	Sclerolaena eurotioides
	Tecticornia halocnemoides
	Tecticornia sp.
Fabaceae	*Acacia burkittii*
	Acacia erinacea
	Acacia hemiteles
	Acacia inceana subsp. *inceana*
	Acacia jennerae
	Acacia masliniana
	Acacia nyssophylla
	Acacia tetragonophylla
	Alectryon oleifolius subsp. *canescens*
	Jacksonia arida
	Senna artemisioides subsp. *filifolia*
	Senna stowardii
	Swainsona canescens
Frankeniaceae	*Frankenia setosa*
Geraniaceae	**Erodium cicutarium*
Goodeniaceae	*Scaevola spinescens*

Family	Species
	Goodenia berardiana
Haloragaceae	*Haloragis trigonocarpa*
Hemerocallidaceae	*Dianella revoluta var. divaricata*
Lamiaceae	*Westringia rigida*
Loranthaceae	*Amyema miquelii*
Marsileaceae	*Marsilea ?hirsuta*
Montiaceae	*Calandrinia ?hortiorum*
	Calandrinia disperma
	Calandrinia eremaea
	Calandrinia sp.
Myrtaceae	*Eucalyptus ?capillosa*
	Eucalyptus campaspe
	Eucalyptus clelandiorum
	Eucalyptus griffithsii
	Eucalyptus horistes
	Eucalyptus moderata
	Eucalyptus oleosa
	Eucalyptus oleosa subsp. *oleosa*
	Eucalyptus ravida
	Eucalyptus salmonophloia
	Eucalyptus salubris
	Eucalyptus torquata
	Eucalyptus vittata
	Eucalyptus yilgarnensis
	Melaleuca lateriflora
	Melaleuca phoidophylla
Poaceae	*Eragrostis dielsii*
	Lachnagrostis ?filiformis
	Triodia ?scariosa
	Austrostipa scabra
Polygonaceae	*Duma florulenta*
Proteaceae	*Grevillea acuaria*
	Grevillea sarissa subsp. *sarissa*
Santalaceae	*Exocarpos aphyllus*
	Santalum acuminatum
	Santalum spicatum
Sapindaceae	*Dodonaea lobulata*
	Dodonaea viscosa subsp. *angustissima*
Scrophulariaceae	*Eremophila caperata*
	Eremophila interstans subsp. *interstans*
	Eremophila ionantha
	Eremophila miniata
	Eremophila oldfieldii subsp. *angustifolia*
	Eremophila oppositifolia subsp. *angustifolia*
	Eremophila pustulata
	Eremophila scoparia
	Eremophila sp?
	Eremophila decipiens subsp. *decipiens*
	Eremophila glabra subsp. *glabra*
	Eremophila pustulata
	Eremophila interstans subsp. *interstans*
	Eremophila interstans subsp. *virgata*
Solanaceae	*Lycium australe*
Zygophyllaceae	*Roepera glauca*
	Roepera ovata

Appendix E: Subterranean Fauna Desktop Review

Bennelongia Environmental Consultants

Mungari Operations: desktop assessment of subterranean fauna values at Castle Hill, Rayjax and Cutters Ridge

Prepared for:

Spectrum Ecology/Evolution Mining

September 2019

Draft Report

Short-Range Endemics | Subterranean Fauna

Waterbirds | Wetlands

Mungari Operations: desktop assessment of subterranean fauna values at Castle Hill, Rayjax and Cutters Ridge

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Report Number: 377

Report Version	Prepared by	Reviewed by	Submitted to Client	
			Method	Date
Draft	Anton Mittra		Email	16-09-2019
Final				

BEC_RJ-CH-CUT_subterranean fauna desktop_16ix2019.docx

EXECUTIVE SUMMARY

Evolution Mining are exploring options to mine at various locations within the Mungari Operations located approximately 20 km north of Coolgardie in the Goldfields region of Western Australia. The focus areas covered by this report are the proposed mine pits at Castle Hill, Rayjax and Cutters Ridge and the proposed tailings storage facility (TSF) to the east of Cutters Ridge. The focus mine pits and TSF are referred to as the study area. This report presents an appraisal of the potential ecological and conservation values of subterranean fauna in the study area based on desktop review.

There is no highly prospective habitat for subterranean fauna in the study area. The primary limiting factor on the occurrence of subterranean species will be the apparent unavailability of well-developed underground spaces such as coarse interstices, vughs, fractures and caverns. The surficial cover of weathered laterite and saprolite is clayey and more or less devoid of significant subterranean spaces. The underlying rock types are not considered prospective. This is supported by the very limited amounts of water produced during bore drilling and the lack of habitat apparent in drill core photos. The proposed mining areas are all outside the extent of the palaeovalley, further reducing prospectivity. The most prospective area for stygofauna is the TSF, though it is expected that only a depauperate community, at best, would occur and any species present would be highly likely to have a range extending beyond the TSF in palaeovalley sediments. Like the rest of the study area, the TSF has very low prospectivity for troglofauna.

At least seven-species of stygofauna have been recorded within the search area, including a stygal annelid worm, a syncarid and five-species of copepod. All the recorded species are known from single bores within, or immediately adjacent to, the mapped extent of the Rebecca palaeovalley near Lake Goongarrie and were collected are well outside the extent of potential influence from works in the study area. While sampling intensity has been limited in the region, samples that were captured in the review collected very few species, demonstrating the relatively low degree of prospectivity in the search area. No Priority Ecological Community calcrete aquifers or other very prospective stygofauna habitats occur close to the study area.

The desktop revealed records of at least eleven species of troglofauna in the search area including two species of spider (Araneae), three species of centipede (Chilopoda), a millipede (Diplopoda), one species of dipluran, a beetle (Coleoptera), a true bug (Hemiptera) and two species of symphylan. The majority of the troglofauna species were recorded near Lake Goongarrie, some 50 km or more to the north of the study area, predominantly in transported colluvial cover material in the Rebecca palaeovalley. One species was collected 78 km to the east of the study area from low greenstone or ironstone hills. As is the case for stygofauna, the small number of records of troglofauna in the search area in part reflects the small number and very limited coverage of previous samples. However, it is also true that geologies that would typically be considered prospective for troglofauna, such as large calcretes and ironstone ranges are largely absent from the vicinity of the study area and wider search area.

It is apparent that there will be minimal dewatering requirements for the proposed mines and subsequently the magnitude of groundwater drawdown around each pit will presumably be very small. This is in part due to the tight geologies resulting in aquifers being confined to various degrees. Coupled with low levels of habitat prospectivity, a very low level of potential impact to stygofauna is inferred. Due to the general lack of subterranean habitat in the geologies of the study area, it is considered unlikely that troglofauna will occur. (This includes the TSF, which has a very low level of prospectivity for troglofauna.) The level of risk posed by developments in the study area to troglofauna is therefore very low.

No further survey is considered to be required to support mining approvals for the study area in regard to subterranean fauna. It is noted that this assessment does not cover areas or developments outside the current study area, including any water supply options, which should be assessed separately.

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1. INTRODUCTION

Evolution Mining are exploring options to mine at various locations within the Mungari Operations located approximately 20 km north of Coolgardie and 30 km west of Kalgoorlie in the Goldfields region of Western Australia. The focus areas covered by this report are the proposed mine pits at Castle Hill, Rayjax and Cutters Ridge and the proposed tailings storage facility (TSF) to the east of Cutters Ridge. (Figure 1). The focus mine pits and TSF are referred to as the study area.

This report presents an appraisal of the potential ecological and conservation values of subterranean fauna in the study area based on desktop review. The aims of the desktop are:

1. Review available geological and hydrogeological information to assess the prospectivity of habitats in the study area for subterranean fauna.
2. Compile and evaluate records of subterranean fauna within the vicinity of the study area (including listed species and ecological communities), assess ranges of recorded species and incorporate these results into the appraisal of prospectivity.
3. Assess potential impacts to subterranean fauna species based on desktop review.

2. SUBTERRANEAN FAUNA FRAMEWORK

Subterranean fauna includes aquatic stygofauna and air-breathing troglofauna. Both groups characteristically have reduced or absent eyes and are poorly pigmented due to lack of light. Subterranean fauna species in caves have often developed vermiform bodies and elongate sensory structures, though species in tighter, non-cave habitats in the wider landscape do not necessarily share these adaptations. Other typical morphological and physiological adaptations in underground species include wing reduction or loss, increased lifespan, a shift towards K-selection breeding strategy and decreased metabolism (Gibert and Deharveng 2002). Except for a few species of fish, all subterranean fauna species in Western Australia are invertebrates.

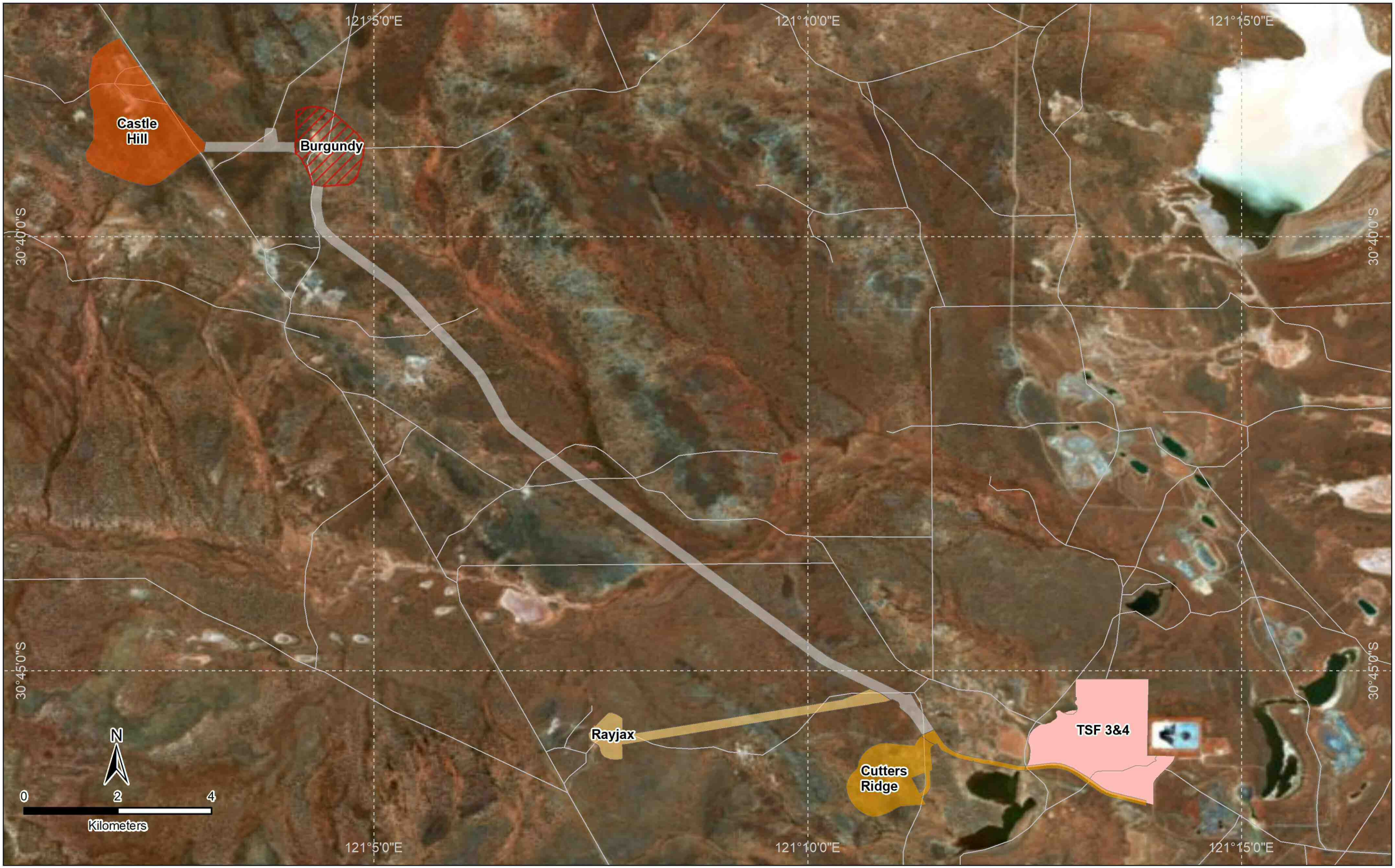
While some subterranean species are obligate inhabitants of groundwater (stygobites) or deep subterranean spaces above the water table (troglobites), others use these habitats only for a proportion of their life cycle (stygophiles and troglophiles). Species with some surface occurrence usually have larger distributions than obligate subterranean species as a result of greater dispersal opportunities.

Although inconspicuous, subterranean fauna contribute markedly to the overall biodiversity of Australia. The Yilgarn, Pilbara and neighbouring regions of Western Australia are recognised as hotspots of subterranean faunal biodiversity, with an estimated 4,000 or more subterranean species likely to occur (Guzik *et al.* 2010), the majority of which remain undescribed. Nearly all subterranean species satisfy Harvey's (2002) criteria for short-range endemism (SRE), namely a total range of less than 10,000 km^2, occurrence in discontinuous or fragmented habitats, slow growth and low fecundity.

Given that species with small ranges are more vulnerable to extinction following habitat degradation than wider ranging species (Ponder and Colgan 2002), it follows that subterranean species are highly susceptible to anthropogenic threats such as groundwater abstraction or excavation. In Western Australia the Environmental Protection Authority (EPA) requires consideration of subterranean fauna as part of environmental impact assessment (EPA 2016a, b).

3. POTENTIAL HABITAT

Troglofauna occupy subterranean spaces, such as alluvial interstices, voids and fissures, while stygofauna inhabit water held by such structures. Stygofauna also occur in the alluvium of hyporheic zones (the confluence of groundwater and surface-water habitats) as well as in groundwater-fed springs. Geology and hydrogeology are significant drivers of the distributions of subterranean species and communities (Eberhard *et al.* 2005; Hose *et al.* 2015; Humphreys 2001). For instance, in arid landscapes, stygofauna are more likely to occur within palaeovalley deposits.



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Author: A. Mittra
Date: 13-09-2019

Legend

- road_lines
- Haul Road
- Cutters Ridge Mine
- Rajax Mine
- Burgundy Mine (not assessed here)
- Castle Hill
- TSF 3&4

Figure 1. Location and layout of the project areas

Highly transmissive geologies tend to support richer and more abundant assemblages of subterranean fauna. For example, clastic alluvial media may host rich assemblages in the interstitial spaces between constituent sand and gravel. Coarse sediments tend to host the richest assemblages while silty or clay-rich substrates are generally not considered prospective (Korbel and Hose 2015). Weathering of consolidated media can also provide inhabitable spaces such as fissures, vughs and caverns. In arid and semi-arid regions, fluctuating groundwater levels and subsequent deposition of carbonate-rich material in palaeochannels has led to the formation of calcrete aquifers that offer habitat similar to karst.

The richest subterranean communities in the Yilgarn are found in palaeovalley calcretes and adjacent alluvial and colluvial units, particularly below the water table, where stygofaunal assemblages are often rich. Survey for troglofauna in the Yilgarn has been very limited when compared to stygofauna though, notably, a rich troglofaunal community was documented in calcrete above the water table around Yeelirrie (45 species, Bennelongia 2015), while 20 species of troglofauna were recorded in calcretes around Lake Way (Outback Ecology 2012). Moderately rich troglofauna communities have also been documented in BIF (Bennelongia 2016) and granite (Bennelongia 2018).

3.1. Local Habitat

A number of sources of information on the physical environment were reviewed to assess habitat prospectivity for subterranean fauna in each component of the study area:

- Geological descriptions in hydrogeology reports (AQ2 2019; Rockwater 2014).
- 100k surficial geology of the Kalgoorlie (3136) map sheet (GSWA 1985) (Figure 2).
- Drill logs for water exploration bores at Rayjax, Cutters Ridge and Burgundy (AQ2 2019). Although the latter is not assessed here, the holes are approximately 200 m from Castle Hill. The locations of the drill holes are shown in Figure 2.
- Photographs of diamond drill cores at Castle Hill, Rayjax and Cutters Ridge (exemplars shown in Plate 1). These were examined to determine the presence of subterranean voids and cavities that could provide potential habitat.
- Mapped distribution of palaeovalleys (Bell *et al.* 2012; Figure 3).

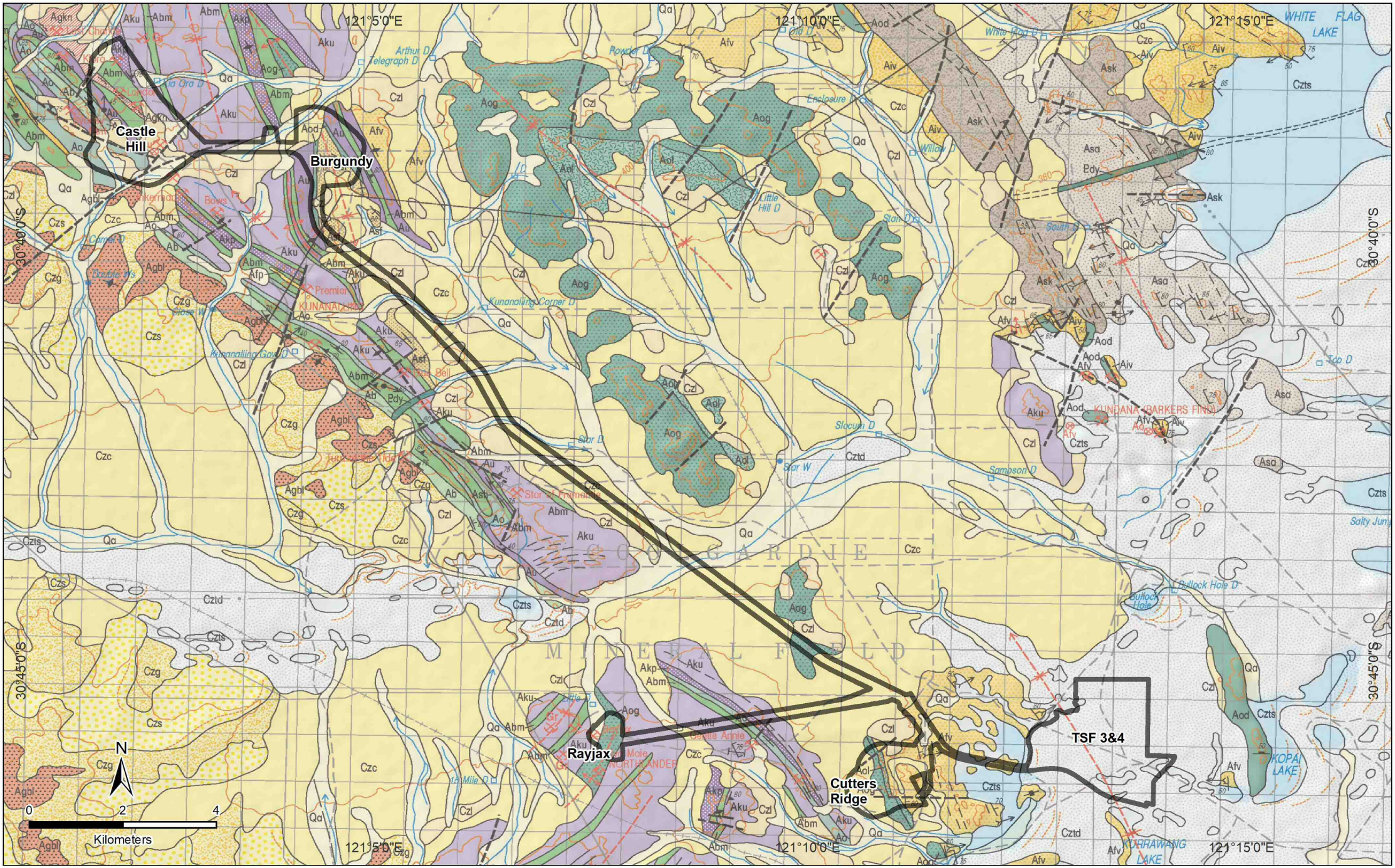
Based on the available logs and mapped surficial geologies, strata above the water table predominantly consist of weathered laterite, saprolite and minor alluvium overlying various mafic and ultramafic rocks.

Unconfined to semi-confined aquifers associated with the transition between weathered and fresh rock, as well as minor confined aquifers associated with fracturing in mineralised zones and quartz veins were observed during water bore drilling in the study area (AQ2 2019). However, minimal groundwater inflows and low levels of permeability were observed, with dewatering requirements likely to relate principally to inflows from surface runoff (AQ2 2019).

3.1.1. Castle Hill

Water bore data is currently not available for Castle Hill, but the geology can be interpreted using 100k mapping (Figure 2) and the single diamond hole provided (Plate 1). Additionally, drill logs for Burgundy (nearby to the east, Figure 1) may be indicative. The geology of Castle Hill consists of various mafic and ultramafic units overlain by weathered saprolite. Some small areas of Quaternary alluvium are also present, corresponding with very minor drainage lines. Significant subterranean spaces appear to be absent and the geologies present are generally not considered prospective for either stygofauna or troglofauna.

Castle Hill, as with the other proposed mine areas, does not occur within a palaeovalley (Figure 3). Based on water bore data from Burgundy, the water table throughout Castle Hill is anticipated to stand at 50 m below ground level (mbgl) or more (based on relief), although there is no information on groundwater quality. However, regardless of water quality, the likely depths to water and the geologies present are likely to be significant limiting factors on the occurrence of stygofauna. It is considered that that the prospectivity for subterranean fauna at Castle Hill is low.



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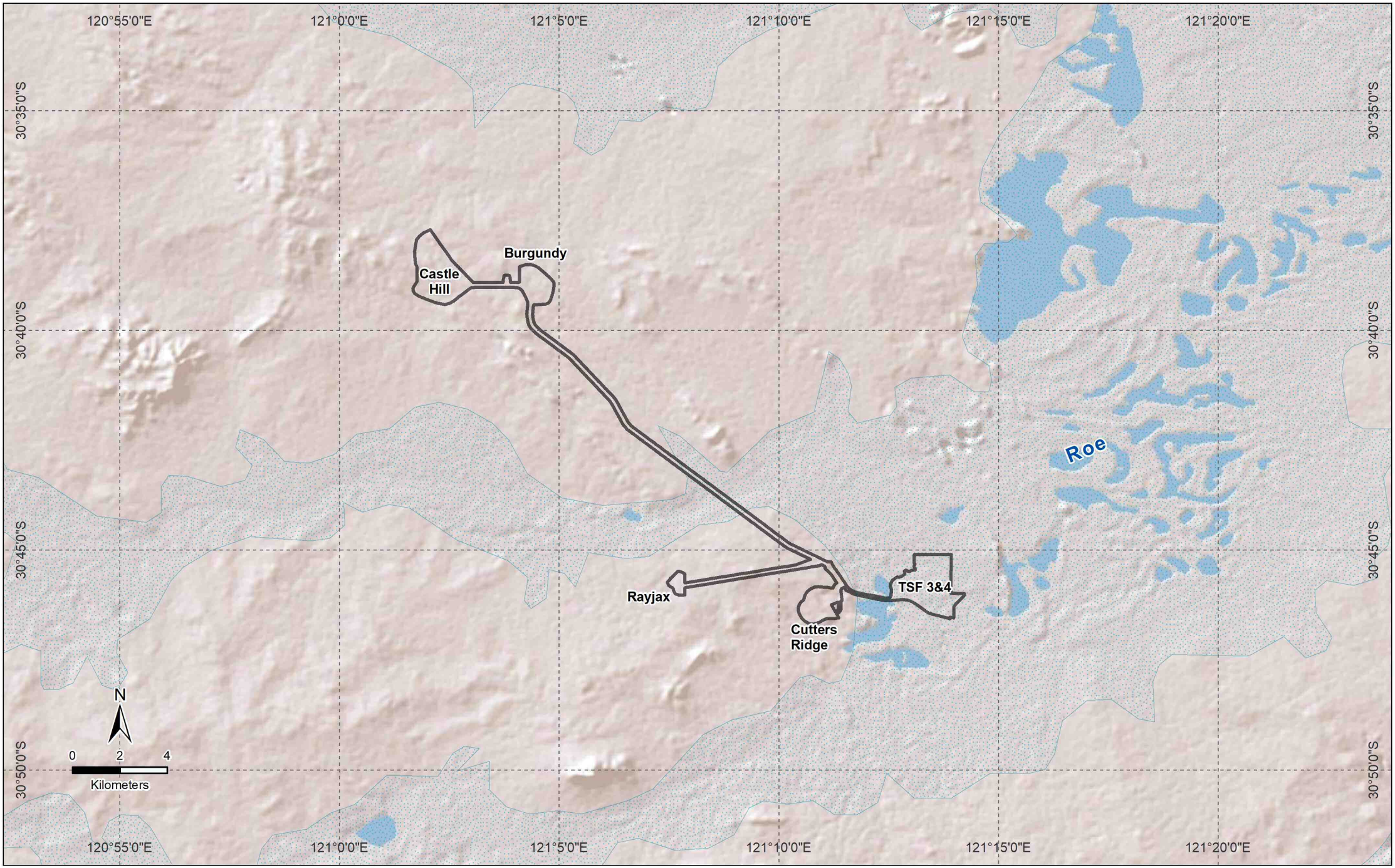
Author: A. Mittra
Date: 16-09-2019

Legend

Study area

Drill log

Figure 2. Geology of the Kalgoorlie 3136 map sheet and locations of available drill logs



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Date: 16-09-2019

Legend

Study area | WASANTPalaeoval... | lakes and playas

Figure 3. Distribution of palaeovalleys in the vicinity of the study area

3.1.2. Rayjax

In addition to mapped surficial geology (Figure 2), drill logs from three water bores (AQ2 2019) and a diamond core (Plate 1) provide direct information on the stratigraphy of Rayjax, which predominantly comprises gabbro with some dolerite, porphyry and ultramafics, with a thin (around 11 m) veneer of weathered laterite. There is little to no development of significant subterranean spaces and the geologies present are not typically considered prospective for subterranean fauna.

Depth to the water table, at 19.41 mbgl, is in itself unlikely to be a major limitation on the occurrence of stygofauna, though there is no information on water quality. However, Rayjax is outside the mapped extent of the palaeovalley (Figure 3) and the very low degree of permeability and poor yields of water observed during drilling and airlift testing (AQ2 2019) further suggest a very low level of habitat prospectivity for stygofauna.

3.1.3. Cutters Ridge

The surface geology of Cutters Ridge comprises metamorphosed gabbro and metamorphosed granodiorite flanked by felsic vocanoclastics, colluvium and weathered saprolite and there are also very small pockets of alluvium coinciding with drainage lines (Figure 2). Some thin quartz veins were also encountered within the surficial saprolite (AQ2 2019). As with the deposits above, there is little to no development of significant subterranean spaces and geologies within Cutters Ridge are not typically considered prospective for subterranean fauna. Cutters Ridge occurs outside the palaeovalley (Figure 3) and very little water was encountered during drilling, with flows drying quickly, indicating aquifer confinement. These geological and hydrogeological factors point to low prospectivity for subterranean fauna.

3.1.4. TSF

Drill logs are not available for the TSF, whose geological setting can instead be interpreted through mapped surficial geology. The geology comprises stabilised dunes of sand, silt, gypsum and probably saprolite adjacent to playas within the palaeovalley. Despite being within the palaeovalley, the TSF itself is unlikely to host a more than a depauperate stygal community and is even less likely to host troglofauna. This is primarily due to the lack of subterranean spaces within the very fine-grained geology. For troglofauna, prospectivity is also likely to be limited by shallow depths to the water table, with the caveat that no direct information on groundwater is available for the TSF at present. The geological units within the TSF with the potential to host subterranean fauna appear to be widespread and connected externally, suggesting that any species present would be likely to have ranges larger than the TSF itself.

3.2. Summary of potential habitat

Based on the information available, there is little in the way of prospective habitat for subterranean fauna in the study area. The primary limiting factor on the occurrence of subterranean species will be the apparent unavailability of well-developed underground spaces such as coarse interstices, vughs, fractures and caverns. The surficial cover of weathered laterite and saprolite is clayey and more or less devoid of significant subterranean spaces. The underlying rock types are not considered prospective and this is supported by the very limited amounts of water produced during bore drilling. The proposed mining areas are all outside the extent of the palaeovalley, further reducing prospectivity.

The most prospective area for stygofauna is the TSF, though it is expected that only a depauperate community, at best, would occur and any species present would be highly likely to have a range extending beyond the TSF in palaeovalley sediments. Like the rest of the study area, the TSF has low prospectivity for troglofauna.

Plate 1. Exemplar photographs of diamond drill cores examined to determine the presence of subterranean fauna habitat.
First row – Castle Hill; second row – Rayjax; third row – Cutters Ridge.

4. PREVIOUS RECORDS OF SUBTERRANEAN FAUNA

To further inform the appraisal of the prospectivity of the Project area, records of both stygofauna and troglofauna were compiled from Western Australian Museum (WAM) and Bennelongia databases within a square search area of 2 decimal degrees centred on the approximate centroid of the study area (30.705° S, 121.105° E). Resultant species data were investigated spatially and cross-referenced with other records, including those outside the search area, to determine the distribution of each species relative to the Project. Higher-order identifications were not regarded as distinct species, unless they belonged to taxa that had otherwise not been recorded. The distribution of records of stygofauna and troglofauna identified within the search area are shown in Figure 4 and Figure 5.

4.1. Stygofauna

The desktop revealed records of at least seven-species of stygofauna within the search area, including a stygal annelid worm, a syncarid and five-species of copepod (Table 1). A small number of nematode worms and rotifers have also been collected in the search area in stygofauna samples but, as these groups are typically not assessed due to uncertain degrees of groundwater dependence and poorly resolved taxonomies, these records are not considered further. All the records of stygofauna in the

search area are from the Bennelongia database. (There were no records at the WAM of stygofauna in the search area.)

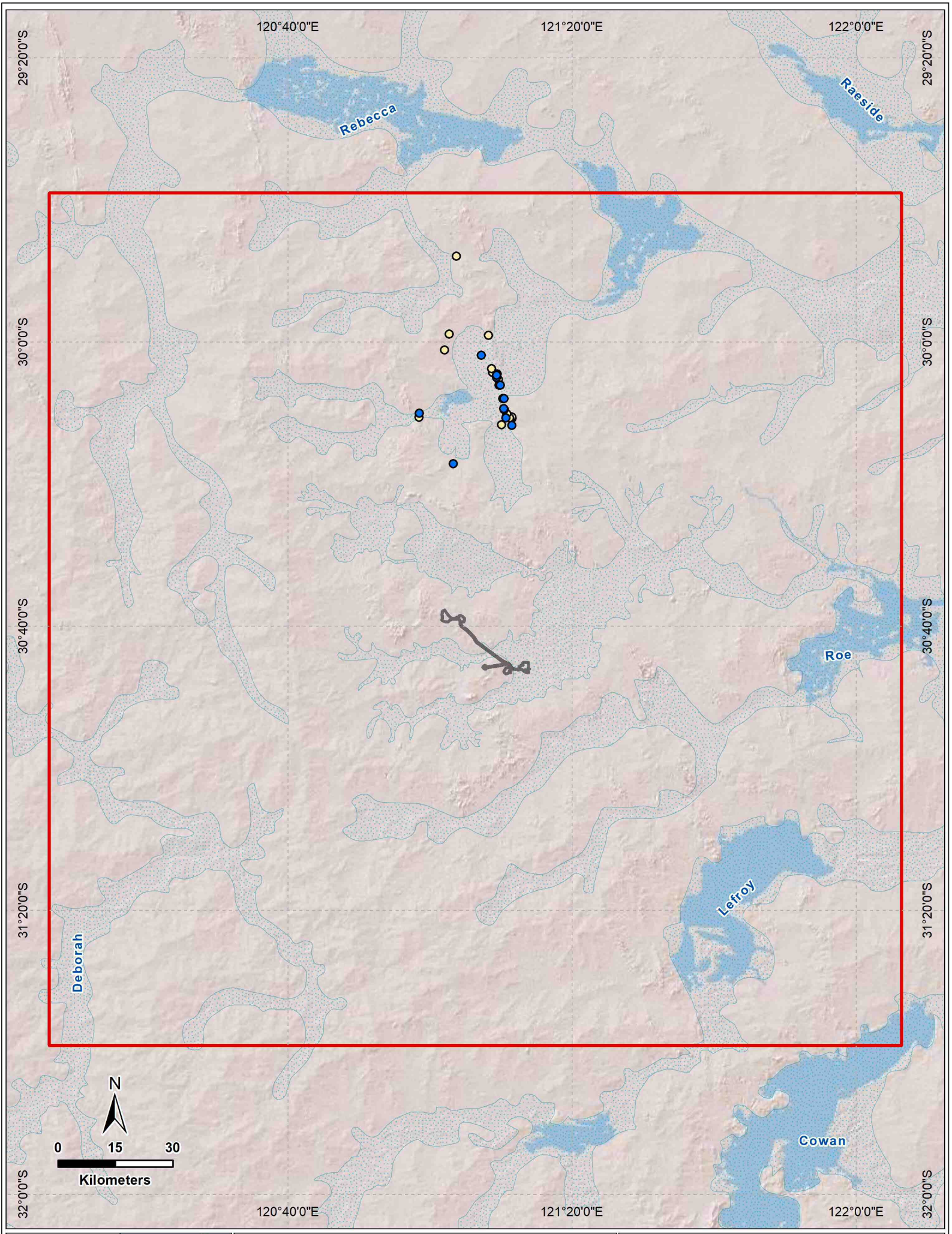
Table 1. Previous records of stygofauna within the search area.
Higher order identifications that may belong to other recorded taxa are denoted with asterisks (*).

Higher Classification	Lowest Identification	Total no. of bores	Comments
Annelida			
Clitellata			
Enchytraeida			
Enchytraeidae	Enchytraeidae `BOL029`	1	Collected 66 km north of the study area.
	Oligochaeta sp.*	1	Higher order identification.
Arthropoda			
Malacostraca			
Syncarida			
Bathynellidae	*Pilbaranella* `BSY178`	1	Collected 68 km north of the study area. Known only from one bore within the Rebecca palaeovalley. Range unknown.
Maxillopoda			
Cyclopoida			
Cyclopidae	*Halicyclops eberhardi* s.l. `BCY062`	1	Collected 38 km north of the study area. Known only from one bore in alluvium adjacent to (and possibly within) the Rebecca palaeovalley. Range unknown.
Harpacticoida			
Ameiridae	*Megastygonitocrella* `BHA247`	1	Collected 51 km north of the study area. Known from a single bore within the Rebecca palaeovalley. Range unknown.
	Stygonitocrella s.l. `BHA245`	1	Collected 38 km north of the study area. Known only from one bore in alluvium adjacent to (and possibly within) the Rebecca palaeovalley. Range unknown.
	Stygonitocrella s.l. `BHA246`	1	Collected 67 km north of the study area. Known from a single bore within the Rebecca palaeovalley. Range unknown.
Miraciidae	*Schizopera* `BHA248`	1	Collected 38 km north of the study area. Known only from one bore in alluvium adjacent to (and possibly within) the Rebecca palaeovalley. Range unknown.

All the recorded species are known from single bores within, or immediately adjacent to, the mapped extent of the Rebecca palaeovalley near Lake Goongarrie (Figure 4). None of the recorded species have been formally described and, combined with the fact that each species is known from a single bore, it is therefore very difficult to predict their likely geographic distributions. However, all the species are well outside the extent of potential influence from works in the study area.

The small number of records of stygofauna species is, at least in part, a result of the limited amount and coverage of stygofauna sampling in the search area (Figure 4, although it is noted that there may be sampling that is not captured by records in the Bennelongia and WAM databases). Nevertheless, samples that were captured in the review collected very few species, demonstrating the relatively low degree of prospectivity in the search area.

A large number of calcrete aquifers in the Goldfields and wider Yilgarn are listed as Priority Ecological Communities (PEC) on the basis that they are known or likely to harbour unique (and often rich) assemblages of stygal communities. None of these PEC calcretes occurs within the search area.



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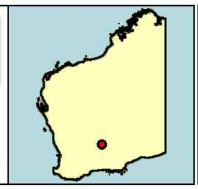
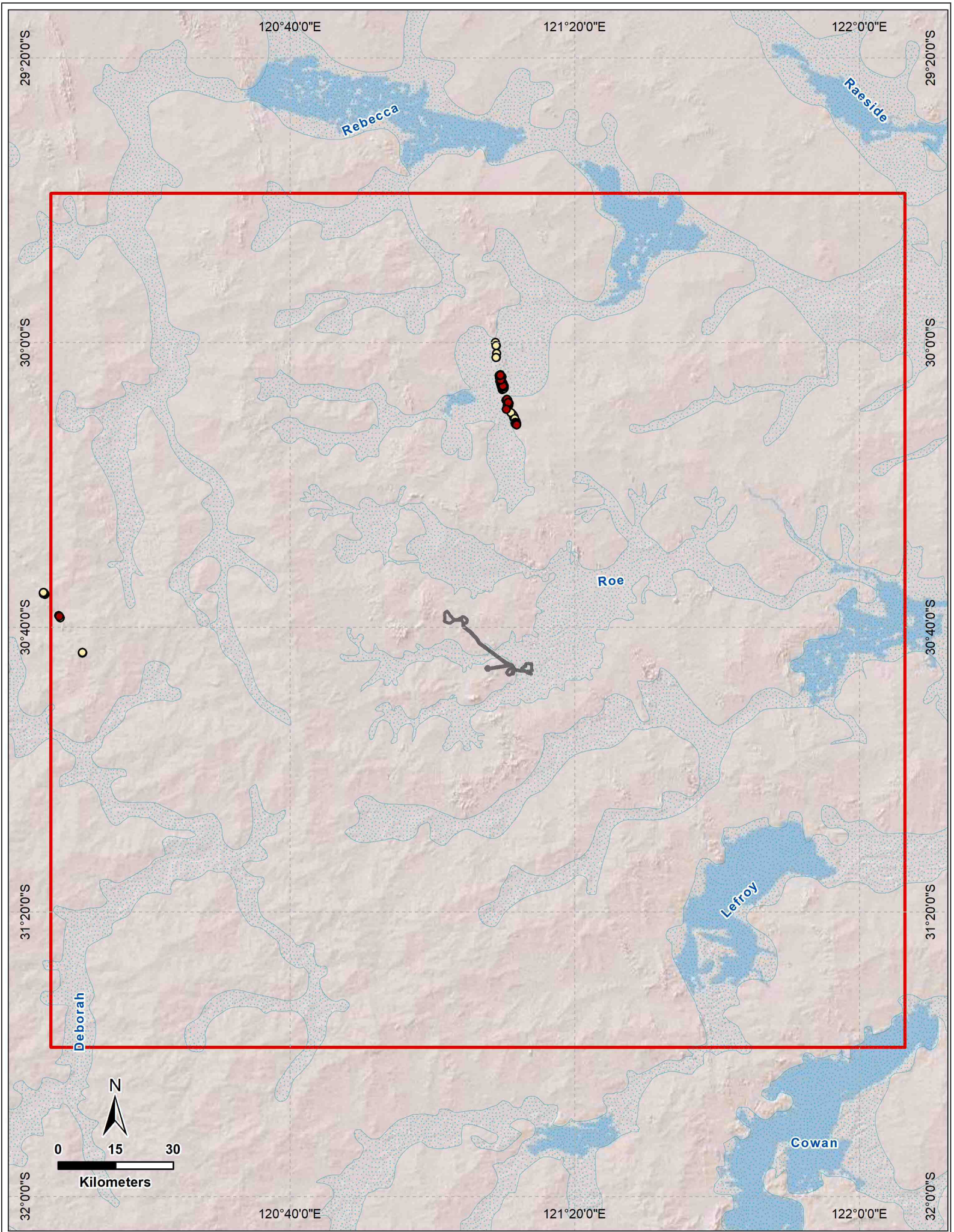
Author: A. Mittra
Date: 02-09-2019



Legend

- Study Area
- Palaeovalley
- 2dd_search_area
- lakes and playas
- Stygofauna sample
- Stygofauna record

Figure 4. Records of stygofauna species within the search area identified through desktop review



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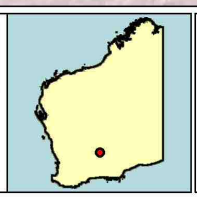

Legend

- Study Area
- Palaeovalley
- 2dd_search_area
- lakes and playas
- Troglofauna sample
- Troglofauna record

Figure 5. Records of troglofauna species within the search area identified through desktop review

4.2. Troglofauna

The desktop revealed records of at least eleven species of troglofauna in the search area including two species of spider (Araneae), three species of centipede (Chilopoda), a millipede (Diplopoda), one species of dipluran, a beetle (Coleoptera), a true bug (Hemiptera) and two species of symphylan (Table 2). All the records came from the Bennelongia database. (There were no records at the WAM of troglofauna in the search area.) The majority of the troglofauna species were recorded near Lake Goongarrie, some 50 km or more to the north of the study area, predominantly in transported colluvial cover material in the Rebecca palaeovalley. One species, the dipluran Japygidae sp., was collected 78 km to the east of the study area from low greenstone or ironstone hills.

As is the case for stygofauna, the small number of records of troglofauna in the search area in part reflects the small number and very limited coverage of previous samples. However, it is also true that geologies that would typically be considered prospective for troglofauna, such as large calcretes and ironstone ranges are largely absent from the vicinity of the study area and wider search area.

Table 2. Previous records of troglofauna within the search area.
Higher order identifications that may belong to other recorded taxa are denoted with asterisks (*).

Higher Classification	Lowest Identification	Total no. of bores	Comments
Arthropoda			
Arachnida			
Araneae			
Oonopidae	*Prethopalpus* `BAR106`	1	Collected 50 km north of the study area. Known from a single bore and collected in transported cover material. Range unknown.
	Prethopalpus `BAR107`	2	Collected from two bores, 50-54 km north of the study area, in transported cover material. Range unknown.
Chilopoda			
Geophilida	Geophilida `BGE040`	1	Collected 56 km north of the study area in transported cover material. Known from a single bore. Range unknown.
	Geophilida `BGE041`	1	Collected 56 km north of the study area in weatehered bedrock. Known from a single bore. Range unknown.
	Geophilida sp.*	1	Higher order identification.
Scolopendrida			
Cryptopidae	*Cryptops* nr *spinipes*	1	Collectected 51 km north of the study area in weathered bedrock. Likely a very widespread species.
Diplopoda			
Polyxenida			
Lophoproctidae	*Lophoturus madecassus*	1	Cosmopolitan species.
Entognatha			
Diplura			
Japygidae	Japygidae sp.	1	Collected 78 km west of the study area, likely in fractured greenstone or ironstone. Range unknown.
Insecta			
Coleoptera			
Carabidae	*Gracilanillus* `BCO186`	1	Collected 54 km north of the study area in transported cover material. Known from a single bore, range unknown.
Hemiptera			
Cixiidae	Cixiidae sp. B02	1	Very widespread morphospecies collected 46 km north of the study area.
Symphyla			
Cephalostigmata			
Scutigerellidae	*Hanseniella* sp.	3	Collected from three bores 49-57 km north of the study area. Not identified to species, range unknown.
	Symphyella `BSYM086`	1	Collected 50 km north of the study area in weathered bedrock. Known from a single bore, range unknown.

5. POTENTIAL IMPACTS

The potential impacts of mining and related operations on subterranean fauna can be broadly divided into primary impacts, namely the impacts causing possible extinction or threat to the persistence of local populations through direct removal of habitat, and secondary impacts that alter or degrade habitat rather than remove it, thereby reducing population densities.

Secondary impacts include pollutants, altered water chemistry, mine blasting and changes to energy and nutrient pathways. Assessing the threat of potential secondary impacts generally requires detailed physicochemical information on the environmental changes expected to occur.

5.1. Stygofauna

The most common factor causing the removal of habitat for stygofauna is drawdown of the watertable, either from mine pit dewatering (if required), or groundwater production in supply borefields. The threat to an individual species will depend on the relationship between its distribution and the spatial and vertical magnitude of drawdown.

It is apparent that there will be minimal dewatering requirements for the proposed mines (AQ2 2019) and subsequently the magnitude of groundwater drawdown around each pit, in terms of both depth and horizontal extent, will presumably be very small. This is in part due to the tight geologies resulting in aquifers being confined to various degrees.

As a result of tight geologies, low permeability and situation outside the palaeovalley, the prospectivity of the study area for stygofauna is generally very low. This is further supported by the small number of species recorded in the region, most of which have been recorded within a palaeovalley (though it is true that sampling intensity has been low). To reiterate, it is considered that very few, if any, stygofauna species will occur within the study area, especially in the mine pit areas at Castle Hill, Rayjax and Cutters Ridge.

The TSF area has a slightly higher, but still low, degree of prospectivity for stygofauna. There is currently limited information on groundwater (depth and quality) in the TSF. However, it is likely that any species present will also occur in the palaeovalley beyond the extent of the TSF.

Overall, the development of open cut pits and the TSF within the study area poses a very low level of risk to stygofauna.

5.2. Troglofauna

The main factor causing the removal of habitat for troglofauna is the excavation of mine pits. As for stygofauna, the level of threat to a troglofauna species depends on its distribution relative to the spatial and vertical extent of excavations. The mine pits in the study area will be small (Figure 1) relative to the median ranges of many troglofauna groups (Halse and Pearson 2014).

Due to the general lack of subterranean habitat in the geologies of the study area, it is considered unlikely that troglofauna will occur. (This includes the TSF, which has a very low level of prospectivity for troglofauna.) The level of risk posed by developments in the study area to troglofauna is therefore very low.

6. CONCLUSIONS

Potential habitats in the study area have low to very low prospectivity for subterranean fauna including both stygofauna and troglofauna. It is considered unlikely that subterranean fauna will occur and, if present, communities will consist of very few species. The low number of records of subterranean fauna species in the vicinity of the study area supports this assessment, though sampling has been limited.

6.1. Recommendations

No further survey is considered to be required to support mining approvals for the study area in regard to subterranean fauna.

It is noted that this assessment does not cover areas or developments outside the current study area, including any water supply options, which should be assessed separately.

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